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GENERAL INDEX TO VOL. III.

THE
BRITISH JOURNAL OF SURGERY

INTRODUCTORY.

WE enter to-day upon our third year. Twelve months ago we gave an account of our success; of the welcome which had been so cordially extended to us by all our contemporaries; and of our hopes and ambitions for the future.

We had frankly confessed the chief fault, as it seemed to us, of British surgery: the rigid isolation of the individual surgeon within a hospital community which itself was too often shut off from intercourse with other similar bodies practising the same art, under the same conditions, within the same country. We indicated the signs which caused us to hope that this aloofness—only a manifestation, perhaps, of our insular shyness—was beginning to break down, and that a real desire for free intellectual traffic was declaring itself here and there, with results which promised much for the cause of surgery. It was evident also that a taste was quickly developing among us all for brief visits to our Continental colleagues, for the purpose of seeing the work of the best surgical clinics, of studying the methods there practised, and of discovering the raw material in the minds of those who fashioned from it the thoughts destined to guide our future progress. Just as the individual surgeon was realizing that nothing but good can come from frequent intercourse with his colleagues, so we as a nation were learning that the thinkers or workers in other lands had a message to give us, and a lesson which we might profitably learn.

It has long been admitted that the British contribution to science, whether in surgery or elsewhere, lies in the suggestion of new ideas. The British mind is original. But instances will at once occur to everyone of our neglect, indeed our spurning, of our own new thoughts. It was Disraeli who said that what the British instinctively disliked was not that which was new, but that which was newfangled. Contact with other minds differently constituted from our own, and moulded by other methods, must result in a better appreciation of our own views and ideas, and in a more worthy and purposeful use of them. The mind of France, with its serene austere logic, can give discipline to our strange, fresh, and often unbridled thoughts; for logic is the mind's astringent. France, we know, is the soil upon which many of the great intellectual conflicts have been and are still being fought. France, and the friendship of French

surgeons, have done much and will do more for English surgery. The help that Germany gave was of a different order, and slighter value. The German mind is avaricious: it is a gross feeder, not scrupulous in its choice, nor very discriminating in its taste; it is not severely logical, nor balanced; it lacks insight and judgement, but is nevertheless large and robust. The Teuton is, as Nicole said of Pascal with less truth, a "ramasseur de coquilles," a picker up of shells, with every now and then a pearl. He is collector rather than creator; exploiter rather than explorer.

Our outlook in surgical affairs, however, has been abruptly changed. The war, of Germany's planning and timing, has dealt ruthlessly with surgery, as with all the other affairs of life. It has provided a practice, and is beginning to develop a literature, of surgery, entirely its own. Our first experience of the wounds in this war caused a rude and sudden shock. Soldiers arriving at base hospitals in France or in England were found to have their wounds infected to a degree which probably no one in the present generation of active surgeons had ever seen before. Stupefaction, resentment, anger were felt, and did not lack expression, at the ghastly condition of the wounded, and at the circumstances which allowed these things to happen. In our own pages the conditions of the hospitals at Boulogne were described as offering an "orgy of sepsis." We now know that such things were unavoidable in the warfare as it was then waged. A soldier wounded in the forefront of the battle could not, and in many places still cannot, be taken to an aid-post in order to have his wounds tended, except at the risk of his own life or of the lives of those who must carry him. The gallantry and the quiet heroism of the officers of the R.A.M.C. were magnificent, but costly. The lives sacrificed of officers who could ill be spared, and the many honours bravely and worthily won are a melancholy but telling tribute to the splendid achievements of a corps of whom the whole nation is proud.

Withdrawal of the wounded from the firing line was delayed, not by the absence or inefficiency of medical aid, but by the certainty that the enemy would spare no one, and by the quickly-gained experience that even a glimmer of light on a dark night to aid in the moving of the wounded would at once attract a storm of shrapnel or of shell. The first field-dressing, adequate as it perhaps was for one wound, was hopelessly inadequate for the multiple and hideous wounds inflicted by shrapnel or hand grenade. The soldier, before being struck, had perhaps been fighting for days or even weeks; he had little or no chance of carrying out the measures of personal cleanliness which are inbred in Thomas Atkins, and which make him the dandy among the soldiers of the world. The earth which soiled his clothes and limbs was perhaps the most fertile of all the cultivated lands of Europe. The bullets by which the wounds were caused travelled with a speed so great that on striking a limb every solid tissue that lay in the path of a bullet acquired a velocity

from it and became itself a projectile which was driven widely and with great force into all the parts around. A bullet, we learnt, had three movements, a forward one of immense velocity, a rotary movement imparted by the rifling in the barrel of the gun, and for the first few hundred yards an oscillatory movement, a " mouvement de bascule," in which the base of the projectile moved round the circumference of a circle, or an ellipse, while the point remained steady. At the moment of impact an infinitely brief arrest of the point of the bullet occurred, so that the base, not lying directly behind the point, had time to begin to " catch up " with it. The result was that the projectile did not cleave its way through the limb as did the bullet in the South African War, but within the first 500 yards of its flight produced an ' explosive ' effect, which so damaged the tissues that a belief, probably quite unfounded, in the use of dum-dum bullets by the enemy was widely accepted. It was, moreover, soon realized that by reason of these various qualities of the projectile—its high velocity, the transference of its activity to all the parts it encountered, its rolling movement within the wound—not only was a gaping track through the tissues formed, but a tremendous concussion, or even death, of the parts immediately surrounding the track was inflicted also. The wounds were deep, irregular, anfractuous, with hidden pockets or remote recesses. The micro-organisms carried in were those from the soil, were therefore of fæcal origin, very often anaerobic, and of marvellous fertility. Tetanus, or gas gangrene, or virulent septic processes made haste to develop.

The lessons which Lister had learnt in the early days of his trials with the antiseptic methods had to be learnt by us again. Failures were spoken of; the failure of the antiseptic method; the failure of the aseptic method. The failure, if such there were, lay in our lack of appreciation of what it was that Lister had taught. If we now read the works of the greatest of our masters, we shall find that, though the distinction is nowhere verbally drawn, a difference is clearly recognized between the prophylactic value and the therapeutic use of antiseptics.

Lister writes, " The original idea of the antiseptic system was the exclusion of all microbes from wounds." Again, " During the operation, to avoid the introduction into the wound of material capable of inducing septic changes in it, and secondly to dress the wound in such manner as to prevent the subsequent entrance of septic mischief." Again, " In wounds already septic, attempts are made with more or less success to restore the aseptic state." Again, " In speaking of the antiseptic system of treatment, I refer to the systematic employment of some antiseptic substance so as entirely to prevent the occurrence of putrefaction in the part concerned, as distinguished from the mere use of such an agent as a dressing."

It is clear that the chief point made is that antiseptics applied before the

infliction of a wound, or quite early to an infected wound, before the microbes have gained a hold, prevent those disastrous results—suppuration, gangrene, erysipelas—which were the constant companions of the surgeon in the olden days. If the antiseptics, however strong, were applied after the infective processes were in full activity, there was only a hope that these might in some degree be mitigated.

Throughout the large number of the laboratories which the War Office has sent to France, and especially in Boulogne under Sir Almroth Wright, the bacteriology of the wounds in this war have been studied, and research made as to the best methods of applying the knowledge so gained to the treatment of wounds. Many years ago Sir A. Wright pointed out the efficacy of the method of 'lymph lavage,' and he has again directed attention to this procedure. The 'hypertonic' method, properly carried out, would appear to have given results of a very remarkable kind, and is most worthy of an extended trial.

Sir Watson Cheyne, and those who have worked with him, have devoted much labour and great ingenuity to the discovery of a method by which the period of effective action of antiseptics within a wound may be prolonged. The use of various 'pastes' is recommended, and good results from this method also are expected. The new problems, it will be seen, are being vigorously and variously attacked by men upon whom the profession has long been accustomed to rely with confidence.

It has been said that in the early days of the war dissatisfaction was expressed with the medical organization in respect both of material and of men. A closer knowledge of the problems which confronted the administration during that critical time has however removed the reproach. It is true that the machine did not run smoothly all at once—but what machine after much inaction will not creak or " slip a cog " now and then when called upon to do a work immensely greater than that for which it was built ? The work of organization is perhaps not even yet complete. Greater results for good may come from a different grouping of men, from closer union and sympathy between parts at present estranged, from the formation of a central brain to receive messages from the periphery and to transmute these into impulses of proper value directed according to their needs to all the distant parts. The results already achieved by those responsible for the chief administration in times of so great stress, with problems so new, momentous, and gigantic, are surely deserving of the highest recognition it is in our power to give. Grim necessity once more is served.

GEORGE JAMES GUTHRIE.

1785—1856.

GUTHRIE was born in London, May 1, 1785. His grandfather, a Scotsman, served with the army at the battle of the Boyne. His father succeeded a maternal uncle, a retired naval surgeon, in the management of a business for the sale of Emplastron Lithargyri. Guthrie was sent to school very early, and had the good fortune to be taught French by the Abbé Noel, with such success that in after life he was often mistaken for a French *émigré*. At the age of thirteen he accidentally came under the notice of Mr. Rush, Inspector-general of Army Hospitals, who decided that he should be apprenticed to Dr. Phillips, a surgeon living in Pall Mall. In this capacity he attended the Windmill-street School of Medicine, and was one of those into whose arms William Cruikshank—Dr. Johnson's "Sweet-blooded man"—fell when delivering his last lecture on the brain on June 27, 1800. From June, 1800, to March, 1801, Guthrie served as hospital mate at the York Hospital, Chelsea, which then occupied a part of what is now Eaton-square. Surgeon-general Keate issued an order that all hospital mates must be Members of the College of Surgeons. On the day following the appearance of the order Guthrie presented himself, was examined and approved by Keate himself, and made so favourable an impression that he was at once posted to the 29th Regiment. Guthrie was then sixteen years of age, his colonel was twenty-four; but notwithstanding the youth of both, it was generally agreed that no regiment was better commanded or better doctored.

Guthrie accompanied the 29th as assistant surgeon to North America, rémaining there until 1807, when he returned with the regiment to England, and was immediately sent out to the Peninsula. Here Guthrie served until 1814, seeing an extraordinary amount of service, and earning the especial commendation of the Duke of Wellington. He acted as Principal Medical Officer at the battle of Albuera, although he was but twenty-six years old, and one evening had on his hands three thousand wounded, with four wagons, and only such equipment as the regimental surgeons carried in their panniers, the nearest village being seven miles away. In 1812 he was appointed to act as Deputy Inspector of Hospitals, but the Medical Board in London refused to sanction the appointment on account of his youth.

At the end of the campaign he was placed upon half pay, and began to practise privately in London, attending the lectures of Bell and Brodie at the Windmill-street School of Medicine. As soon as the result of the battle of Waterloo was known, Guthrie hastened to Brussels. He was enthusiastically received by his old comrades, and was successful in amputating at the hip and tying the peroneal artery in the leg. On his return to London he was given the charge of two clinical wards at the York Hospital,

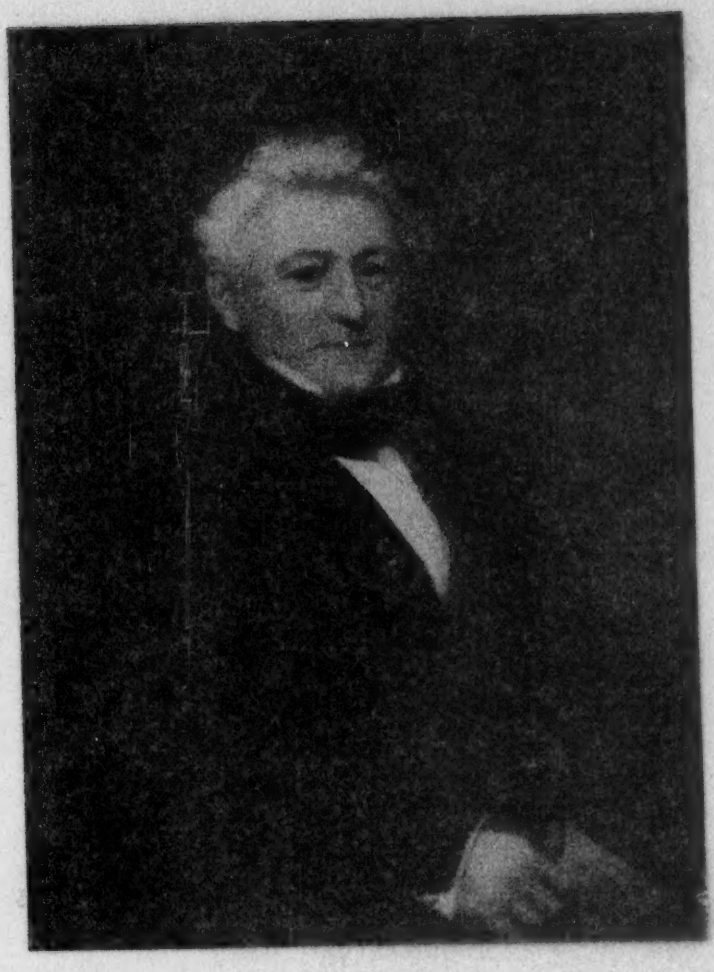
with a promise that the worst surgical cases should be sent into them. This duty he discharged for two years, and it enabled him to commence a series of lectures which were continued gratuitously to all officers of the public services for the next twenty years. At the end of the first course in 1816–17, the medical officers of the Army, Navy, and the Ordnance presented him with a silver loving-cup appropriately inscribed. This cup has become an heirloom in the family of the late Henry Power, F.R.C.S. In 1816, Mr. Guthrie was instrumental in establishing an infirmary for Diseases of the Eye, which became later the Royal Westminster Ophthalmic Hospital; he was appointed Surgeon, and remained attached to the hospital until 1838, when he vacated the post in favour of his son, C. W. G. Guthrie. In 1823 he was appointed Assistant Surgeon to the Westminster Hospital, where he was made fourth Surgeon by the Governors in 1827 as a special mark of their estimation of his surgical reputation and character.

At the Royal College of Surgeons Guthrie was elected to the Council in 1824; as Professor of Anatomy, Physiology and Surgery, he lectured in the years 1829 and 1830, probably taking as his subjects, "The Diseases and Injuries of Arteries," and "The Anatomy and Surgery of Inguinal and Femoral Hernia." He became an Examiner in 1828, and served the office of President in 1833, 1841, and 1854.

He died suddenly of heart disease on May Day, 1856, the anniversary of his birth. He was twice married, and had a family of two sons and one daughter, none of whom left issue. He is described as a man of active and robust frame, keen and energetic in appearance, with remarkably piercing black eyes. Shrewd and quick, he was at times very outspoken and inconsiderate in speech; but behind his military brusqueness was much kindness of heart. He was very popular as a lecturer, his lectures being full of anecdotes and illustrative cases. He was noted for his coolness as an operator and for the delicacy of his manipulation.

Guthrie's unrivalled experience in Military Surgery, gained during the later years of the Peninsular War, and at the most receptive period of his life, justly entitles him to be called "The English Larrey," enabling him to advance the science and practice of surgery more than any other army surgeon since the time of Wiseman. The changes he introduced into military surgery are well summed up by Major H. A. L. Howell, R.A.M.C., who says, "Before his time it was usual to treat gunshot wounds of the thigh by placing the limb on its side. He introduced the straight splint. He differed from Hunter in the treatment of gunshot injuries requiring amputation, advocating primary amputation, whilst Hunter was in favour of the secondary operation. After Albuera, he introduced the practice of tying both ends of a wounded artery at the seat of injury—also contrary to Hunter's teaching, for Hunter tied the artery above the injury. Guthrie's experience in the field was certainly very much greater than Hunter's, and Guthrie's practice was soon accepted by the practical surgeons who had gained their experience in the Peninsula. Guthrie advocated the destruction with mineral acids of the diseased tissues in cases of 'hospital gangrene.'"

In connection with ophthalmic surgery, Guthrie advocated extraction of the the lens in cataract, and was one of the first to describe congenital



GEORGE JAMES GUTHRIE

Reproduced from the Painting in the Royal College of Surgeons, London.

opacity of lens. On the other hand, his experience in Portugal led him to be heterodox in the treatment of syphilis, for he published a paper on its treatment without the use of mercury, which had a widely-spread influence upon the profession.

The work by which Guthrie is best known is *A Treatise on Gunshot Wounds*, first published in 1815. It may still be read with pleasure for the graphic accounts of the military surgery of a by-gone age, which show how our present knowledge was obtained. *The Commentaries on the Surgery of the War in Portugal, Spain, France, and the Netherlands, from the battle of Roliça in* 1808 *to that of Waterloo in* 1815, *revised to* 1853, of which a new edition was published in 1855, is a digest of the treatise on gunshot wounds. It forms the substance of Guthrie's public lectures, and contains his matured opinion on military surgery. In 1819, soon after his appointment to the Royal Westminster Ophthalmic Hospital, Guthrie published a *Treatise on the Operations for the formation of an Artificial Pupil*, which in 1823 he included in a larger work entitled *Lectures on the Operative Surgery of the Eye*. These lectures reached a third edition in 1838.

ON THE CHARACTER, SIGNIFICANCE, AND PROGNOSTIC VALUE OF PERITONEAL EXUDATES.

By ROBERT B. CARSLAW, Glasgow.

This investigation, undertaken chiefly for the purpose of determining whether drainage of the general peritoneal cavity was ever necessary in cases of diffuse peritonitis, soon assumed broader lines, and included an estimation of the character, significance, and prognostic value of peritoneal exudates. The results are based on an examination of eighteen cases of appendicitis, four cases of perforated gastric or duodenal ulcer, one of tubo-ovarian abscess, and one of femoral hernia, operated on by me between January and May, 1914. These cases do not represent all those operated on during that period, as for various reasons it was often impossible to obtain the material required.

I have read as much of the recent work on this subject as I have been able to obtain, although reference is made to only a few of the writers, and all the observations not distinctly stated to be derived from other sources have been at least corroborated by myself.

TECHNIQUE.

The peritoneal fluid was obtained, by means of long glass pipettes introduced through the operation wound, from the region of maximal infection in the cases of diffuse peritonitis, from the region into which leakage was taking place in the cases of leaking appendix abscess, and from the pelvis in the remaining cases.

Immediate Examination.—In those cases in which the fluid was examined during the operation, a single drop was spread on a slide, rapidly dried, stained for one minute with carbol-thionin-blue, and examined with a $\frac{1}{12}$ oil-immersion objective.

Culture.—At the conclusion of the operation cultures were made on ordinary agar or blood agar. The remainder of the fluid was used for films without any preliminary washing or centrifuging.

Films.

Fixation.—1. By heat; or,

2. With saturated solution of perchloride of mercury (five minutes), absolute alcohol (five minutes), Gulland's fluid (five minutes), or 1 per cent solution of osmic acid (five seconds).

Staining.—1. Carbol-thionin-blue was found to be most useful for films examined during the operation, and for the determination of the presence of bacteria and of phagocytosis of bacteria and cells. With this stain, however, it was often impossible to differentiate between large mononuclear leucocytes and small endothelial cells.

2. Leishman's stain was the most generally useful.

3. Saathoff's modification of Pappenheim's pyronin methyl-green was used in every case, owing to the very marked differentiation it gave between large mononuclear leucocytes and endothelial cells.

4. The 'indophenol-synthesis' test for oxydase, used in conjunction with the above methods of staining, enabled one to differentiate accurately between lymphocytes and large mononuclear leucocytes, and between large mononuclear leucocytes and endothelial cells. This reaction, and its usefulness, will be more fully described when dealing in detail with the various cells of the exudate.

The Differential Count.—This was made with a $\frac{1}{12}$ oil-immersion objective and a mechanical stage.

In one case (*Case XVI*), owing to the scantiness of the fluid and the scarcity of the cells, only 500 were counted; in another (*Case XIV*) 5000 were counted, because of the extensive clumping of the large mononuclear leucocytes; in ten cases 3000 were counted, because of the clumping of polymorphonuclear leucocytes or large mononuclear leucocytes, or both; in the others either 1000 or 2000 were counted, the number depending on the uniformity of the films.

Phagocytosis.—In estimating the number of cells showing phagocytosis to bacteria, no attempt was made to count the actual number ingested by each cell, but where the matter was of importance a note was made whether the cells contained few or many bacteria.

THE CELLS OF THE PERITONEAL EXUDATE: THEIR CHARACTER, DIFFERENTIATION, ORIGIN, AND FUNCTION.

I have recognized in the exudate the following cells:—

(1) *Endothelial cells;* (2) *Large hyaline mononuclear leucocytes;* (3) *Polymorphonuclear leucocytes with fine neutrophil granules; Polymorphonuclear leucocytes with coarse eosinophil granules;* (4) *Lymphocytes. Mast cells with granules showing metachromatic staining, and red blood-corpuscles, were also identified.*

Differentiation between Endothelial Cells and Large Mononuclear Leucocytes.—Most writers on peritoneal exudates, when referring to large mononuclear cells which show great phagocytic activity, have expressed doubt regarding their true character and origin.

> Muir[1] states that, after injections of *Staphylococcus pyogenes aureus*, many of the phagocytic cells in the peritoneal exudate are hyaline leucocytes which increase in size, and that others are probably endothelial cells.
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> Beattie,[2] after describing the proliferation of the endothelial cells and the accumulation of large mononuclear leucocytes in the omental vessels, points out that there is great difficulty in distinguishing between these two types of cells after migration from the vessels. By careful staining he has been able with comparative ease to distinguish them in the early stages, but "this distinction becomes gradually lost as the cells enlarge and function more actively." He states further that "the origin of the large mononuclear leucocyte is still a matter of uncertainty; the resemblance between them and the cells derived from the endothelium by active proliferation suggests that they may be derived from some endothelial structure. This is further supported by the fact that both kinds of cells may function in the same manner." He concludes that, in the peritoneal fluid, the mononucleated phagocytes are derived partly from the serous, vascular, and lymphatic endothelium, and partly from the large mononuclear leucocytes.
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> Beattie and Dickson[3] admit that "between these mononuclear cells of endothelial origin and the large mononuclear leucocytes which have emigrated from the vessels, we are not able to differentiate."
>
> Wilkie,[4] in a recent paper on *The Prognostic Value of an Immediate Examination of Peritonitic Exudates*, to which further reference will be made later, states that "the origin of these large mononuclear phagocytes is still uncertain; some of them may arise from the mononucleated cells of the blood, many of them probably come from the endothelium of the capillaries, while others arise from the endothelial lining of the peritoneal cavity."

I have been able to show that these 'mononuclear phagocytes,' which consist of the two different types of cells, the endothelial cells and the large

mononuclear leucocytes, not only have two very distinct and different sources of origin, but also can easily be distinguished from each other. By staining with Leishman's stain or with Saathoff's modification of Pappenheim's stain, various differences can be made out which will be referred to in detail later when describing the cells of the exudate, but the only absolutely reliable method of distinguishing between these two types of cells in all stages of their functional activity is the '*indophenol-synthesis*' *test for oxydase.*

The 'Indophenol-synthesis' Test for Oxydase.—

Dunn[5] states that "the synthesis of indophenol from alpha-naphthol and dimethyl-para-phenylendiamin is produced with great rapidity by the polymorphonuclear neutrophil and eosinophil leucocytes, and also fairly rapidly by the large hyaline leucocytes in normal blood . . . but not by lymphocytes nor red blood-corpuscles, nor by normal tissue elements with the exception of parotid and lachrymal-gland epithelium."

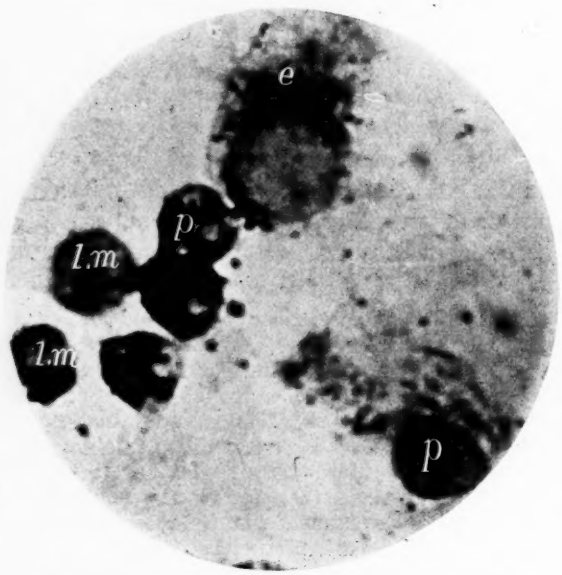

FIG. 1.—*Case XXIII.* APPENDICITIS: LOCALIZED ABSCESS. Duration of symptoms, 50 hours.

Film from peritoneal fluid, showing: (i) Relative proportion of different cells. (ii) Polymorphonuclear leucocytes (*p.*) with very well-marked oxydase reaction. (iii) Two large mononuclear leucocytes (*l.m.*) with oxydase reaction confined to protoplasm opposite hilum of kidney-shaped nucleus. (iv) Endothelial cell (*e.*) with no oxydase reaction, but with fat globules stained with osmic acid; nucleus faintly stained with dilute Bismarck brown. (v) Granules of broken-up leucocytes showing oxydase reaction.
Stain.—'Indophenol-synthesis' test for oxydase.
Counterstain.—Dilute Bismarck brown.

I have examined the peritoneal exudates met with in this series of cases for the oxydase reaction, and also the pus from the primary focus of inflammation. Films stained with carbol-thionin-blue, Leishman's stain, and Saathoff's stain were compared with films, from the same fluid, stained for the oxydase reaction. Again, serial sections of the appendix and omentum from these cases were examined in a similar way, one section being stained with hæmalum and eosin, or with Saathoff's stain, and compared with the next in series stained for the oxydase reaction—similar characteristic fields being chosen.

It was most clearly demonstrated that the synthesis of indophenol was produced by polymorphonuclear and large mononuclear leucocytes, but not by lymphocytes, nor by red blood-corpuscles, nor by endothelial cells, the production taking place whether the cells were active and healthy (as in the 'protective' exudate—see *Fig.* 1) or degenerated (as in the pus of the primary focus).

Polymorphonuclear leucocytes ingested by endothelial cells showed the reaction, whether apparently healthy or degenerated.

Films, if treated without fixation, were not so satisfactory as those in which a 1 per cent solution of osmic acid for five seconds was used, as the dye formation was apt to spread outside the leucocytes. The only objection to the use of osmic acid was the presence of the very darkly-stained fat globules; but as the colour of these differed altogether from the characteristic blue of the indophenol dye, there was no difficulty in distinguishing between them. For the examination of the appendix and omentum, paraffin sections were employed, the tissues being infiltrated in paraffin melting at 40° C. and finally embedded for half an hour in paraffin melting at 52° C. A dilute solution of Bismarck brown (1 gm. to 1000 c.c.) was found to be useful as a counterstain.

1. Endothelial Cells.

Character and Reactions.—

These cells vary greatly in *size*, the variation depending largely, as will be seen, on the length of time which has elapsed since the cell became separated from its original endothelium.

The *shape* also varies; it may be round, ovoid, spindle-shaped, or irregular in outline.

The *protoplasm* is abundant, and spongy in appearance; in the larger forms there is multiple coarse vacuolation. There is often active division of protoplasm. It stains faintly, very light blue with Leishman's stain, pink with Saathoff's stain.

The *nucleus* is round or oval, or in the larger forms crescentic; it is usually central, but may be placed on one side; it is not rich in chromatin, and has a fine reticulum, with one or two very definite nucleoli which are easily demonstrable with the ordinary stains. Many cells have two or more nuclei, and mitotic figures are common. With Leishman's stain the nucleus is lilac, the nucleoli are light blue; with Saathoff's stain the nucleus is light blue, the nucleoli are bright red.

The endothelial cell before separation from its original endothelium can be studied in sections of the inflamed omentum or in films from scrapings of the peritoneum. Although larger than the normal endothelial cell, the attached cell, when compared with the free cell, is seen to be smaller, more regular in outline, its nucleus is richer in chromatin, and its protoplasm is more spongy than vacuolated. As the length of time after detachment increases, the change becomes more marked, until we have a cell which is best described as a "degenerated endothelial cell." Its shape is very irregular, there is very coarse vacuolation of the protoplasm, which stains very faintly and may appear simply as a shadow; the nucleus is very deficient in chromatin; the reticulum is coarser.

Plaques of endothelial cells are found in the exudate which have all the characteristics of the cells before detachment. (One must, of course, make certain that the endothelial cells seen in the films are really present in the peritoneal fluid and are not simply rubbed off the peritoneal surface by the pipette. This accident is more likely to happen in those cases in which the fluid is scanty.)

Origin.—

A.—The Endothelial Surface of the Omentum.—Undoubtedly the main source of the endothelial cells found in the exudate is the endothelium covering the surface and lining the meshes of the omentum.

In the earliest stages the cells become swollen and slightly separated from each other, there is active nuclear and protoplasmic division (mitotic figures being common), the nuclear chromatin becomes vesicular, and the protoplasm vacuolated. The proliferated cells can be seen forming masses of cells on the surface (*Fig.* 2).

After separation has taken place, many isolated cells are seen in the fluid, but also masses of plaques of cells still loosely adherent to each other which are identical in every respect with the cells still attached. In the later stages the endothelium may be almost entirely shed from the surface of the omentum, a few single cells only being still attached.

FIG. 2.—*Case V.*—PERFORATED GASTRIC ULCER: GENERAL PERITONITIS.

Duration of symptoms, 36 hours.

Section of omentum, showing: (i) Fibrinous exudate (*f.e.*) containing many polymorphonuclear leucocytes. (ii) Great proliferation of surface endothelium, some cells still attached, some shed; some nuclei darkly, some lightly stained; in some one or two nucleoli shown.

Stain.—Iron hæmatoxylin (Weigert).

The endothelial lining of the omental meshes behaves in the same way, but the cells take longer to separate, and after the surface endothelium has been almost completely detached, the meshes are often found to be full of cells, with cells still undetached lining the space.

The proliferation of the endothelium described above was found in *Case IV*, a localized appendix abscess of five days' duration, with a large quantity of slightly turbid fluid in the general peritoneal cavity in which no organisms were found. In all the other cases in which it was found, organisms were present in the peritoneal fluid.

B.—The Parietal and Visceral Peritoneum.—

Wilkie[4] has found that the removal of the omentum, although it undoubtedly lowers an animal's resistance to peritonitis, does not, in a case which is recovering, appreciably affect either the time of advent or the number of the 'macrophages' in the peritoneal fluid.

Beattie,[2] on the other hand, affirms that the rest of the endothelial surface of the peritoneal cavity plays a very unimportant part in the production of these cells.

The latter has not been my experience. In seven cases of appendicitis

in this series the non-gangrenous portion of the appendix was examined, and in only one (*Case VII*, catarrhal appendicitis) was there no evidence of proliferation of the endothelial surface. In one case many of the actively proliferating cells were still adherent; in the others most of the cells had been shed.

Again, evidence of the not unimportant part that the parietal peritoneum plays in the production of the cells was obtained from examination of films of scrapings of the peritoneum of the abdominal wall in the neighbourhood of the appendix.

In *Case V* (perforation of a gastric ulcer of thirty-six hours' duration), the endothelial covering of the appendix, liver, spleen, and ileum had been shed.

C.—Lymphatic Endothelium.—The endothelium of the lymphatic vessels of the *omentum* also takes part in the production of endothelial cells which are poured out into the peritoneal cavity. The changes seen during proliferation and detachment of the cells are similar to the changes in the surface endothelium, with certain minor differences. The cells tend to be less round in shape, and to have an oval nucleus. They often become detached from the wall of the vessel while still adherent to each other, and are thus found as a row of detached cells lying free in the lumen. The vessel is often quite full of the detached cells, which are also found in the surrounding tissues.

FIG. 3.—*Case XXI.*—APPENDICITIS: SPREADING PERITONITIS. Duration of symptoms, 2½ days.

Section of appendix (non-gangrenous area), showing a lymphatic vessel with a collection of endothelial cells. *Stain.*—Iron hæmatoxylin (Weigert).

The lymphatic endothelium in the *appendix* also shows active proliferative changes in cases of appendicitis, this being especially seen in the vessels between the circular and longitudinal muscles (*Fig.* 3).

D.—Vascular Endothelium.—In only two cases (*Case IV*, omentum; *Case XXI*, appendix) have I seen proliferation of the vascular endothelium; in both there was swelling of the cells, with active nuclear division; but in neither case were the cells shed into the lumen.

E.—Lymphoid Tissue.—Although in many of my cases there was apparently an increase in the lymphoid tissue in the omentum and submucous coat of the appendix, this change was not marked, and I could not convince myself that this tissue was, as Beattie[2] suggests, a source of the endothelial cells. This may be due to the fact that my cases were all acute, as increase in

lymphoid tissue is without any doubt a much more marked feature where the *irritant* has been acting for a long time.

Phagocytosis of Bacteria by Endothelial Cells.—

Dudgeon and Ross[6] found that the peritoneal fluid of a guinea-pig inoculated with *Bacillus coli*, after previous hypodermic of opium, and killed fifteen minutes later, contained numerous endothelial cells, all of which were phagocytic; and in the peritoneal fluid of one killed thirty minutes after inoculation, 86 per cent of the cells were endothelial, and of these only 33 per cent were phagocytic.

In the experiments without previous hypodermic of opium, the phagocytosis was longer delayed.

In most of my cases it is obviously quite impossible to give even an approximate estimate of the duration of the bacterial invasion of the general peritoneal cavity.

The endothelial cell is much less actively phagocytic to bacteria than the polymorphonuclear leucocytes. Thus we find in *Cases II*, *VIII*, *XI*, *XVI*, that although bacteria were present in the leucocytes, none were found in the numerous endothelial cells of the exudate. But in almost all the cases in which bacteria were found free in the exudate they were also present in the endothelial cells, the exceptions being *Case XXIV*, in which there were no endothelial cells, and *Case XXII*, in which the bacterial invasion of the general peritoneal cavity was of only three hours' duration. In the fluid obtained sixty hours after the operation in *Case XXII* every endothelial cell seen contained bacteria. Thus, it appears that the phagocytic activity to bacteria, while not showing itself so early as in the case of the polymorphonuclear leucocyte, is very marked in the later stages. It is not only in the free cells that phagocytosis to bacteria is seen; bacteria are found in the endothelial cells on the surface and in the meshes of the omentum, on the surface of the appendix, on the parietal peritoneum, and also in the lymphatics of the omentum.

Phagocytosis of Cells by Endothelial Cells.—

A.—Polymorphonuclear Leucocytes.—

Muir[1] mentions that the day after the injection of *Staphylococcus pyogenes aureus* into the peritoneal cavity, degeneration of the polymorphonuclear leucocyte is seen, and that ingestion of these cells by large phagocytic cells follows.

Beattie[2] found that the polymorphonuclear leucocyte is not ingested until twenty-four hours after inoculation, and that the ingestion is most marked from thirty to forty-eight hours.

Dudgeon and Ross[6] have only occasionally observed two or three polymorphonuclear leucocytes (containing bacteria) ingested by 'macrophages' in their experiments, which did not extend beyond twenty-four hours after inoculation.

Ingestion of polymorphonuclear leucocytes by endothelial cells was seen in all my cases except three.

It was seen in six cases in which no bacteria were found, in one of which (fluid obtained twenty days after operation in *Case XXIII*) the primary focus of inflammation had been removed twenty days previously.

As a rule, the larger the number of endothelial cells present, the smaller

the number showing phagocytic activity; whereas if few endothelial cells were present, the number phagocytic to polymorphonuclear leucocytes was relatively greater.

Phagocytosis of polymorphonuclear leucocytes was shown not only by the free endothelial cells, but also by endothelial cells before separation, in the various situations where proliferation takes place.

Degeneration (at any rate, degeneration which is apparent) of the polymorphonuclear cell does not always take place before ingestion. Thus, in fifteen of my cases there was no apparent degeneration in the cells either free or ingested; in two the ingested cells were degenerated; and in nine there was degeneration in both free and ingested cells.

As a rule it was rare to find more than two polymorphonuclear leucocytes in an endothelial cell, but in *Case X* the endothelial cells, which were of enormous size, contained large numbers in varying stages of degeneration. The degenerated ingested cell was almost invariably surrounded by a 'digestive vacuole' (*Fig.* 4).

B.—Large Mononuclear Leucocytes.—Phagocytosis of large mononuclear leucocytes by endothelial cells has been questioned, as many polymorphonuclear leucocytes in the early stages of degeneration (in which the nucleus to a large extent loses its characteristic lobate appearance) may be mistaken for large mononuclear leucocytes. In six of my cases I was able to convince myself, by using Saathoff's stain, that this does take place (*Fig.* 4), although not to any great extent.

C.—Red Blood-Corpuscles.—In three cases endothelial cells with ingested red blood-corpuscles were seen.

The Function of the Endothelial Cell.—Vacuolation of the protoplasm is seen in the proliferating endothelial cells even before detachment; it is much more marked after the cell is shed, when it is most actively phagocytic. It is also seen in the degenerated cell. Again, it is seen to a slight extent in the endothelial cell in the normal peritoneal fluid, and in the peritoneal fluid obtained twenty days after the operation in *Case XXIII* it was noticed that while there was very marked coarse vacuolation in the degenerated endothelial cells, it was comparatively slight in the young healthy cells present.

Beattie[2] suggests that this vacuolation is due to the discharge of some secretion of the cell (probably a bactericidal ferment) during the period of functional activity. This would explain the important part played by the cell in the early stages of peritoneal inflammation, and also the relatively large proportion of these cells in a recovering peritonitis and in the normal peritoneal fluid.

The Fate of the Endothelial Cell.—The cells degenerate whether they have ingested other cells or not. Thus in *Case IV* (a localized appendix abscess of five days' duration), the peritoneal fluid, in which no bacteria were found, contained 83 healthy and 68 degenerated endothelial cells per 1000; none of the degenerated cells were phagocytic. Again, in the fluid obtained twenty days after the operation in *Case XXIII* (a localized appendix abscess), there were 223 healthy and 34 degenerated endothelial cells per 1000. Of the degenerated cells, 24 contained polymorphonuclear leucocytes, most of which showed degenerative changes. I have not seen any

endothelial cells ingested by endothelial cells: most of them are destroyed in the peritoneal fluid. All stages of this are seen, from the large endothelial cell with irregular, faintly-staining protoplasm, to the last stage, in which the cell is represented by a mere indefinite shadow.

Various writers have discussed the question as to whether any are carried to the viscera.

> Muir[1] found no constant changes in the spleen after intraperitoneal injections; but in one case he saw large cells containing fragments of disintegrated red corpuscles and leucocytes.
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> Beattie,[2] also, could find no traces in liver, kidneys, and lungs, but found changes in the abdominal lymphatic glands which suggested that these acted as storehouses for degenerated endothelial cells. But as these glands were in the inflamed area, he could not convince himself that the degeneration had not taken place in cells formed in the glands.
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> In only one case (an animal injected with peptonate of iron and *Bacillus coli*) did he find marked changes in the spleen. There were large numbers of large mononucleated cells in the sinuses, some phagocytic to other cells; but as organisms were circulating in the blood, these phagocytic cells may well have proliferated in the spleen, and not have been carried there.

In only one of my cases (*Case V*) was a post-mortem examination made. Most unfortunately, the removed abdominal lymphatic glands were lost. There was no evidence of endothelial cells in the liver. There was distinct evidence of endothelial proliferation in the splenic sinuses; some of the cells were apparently active, with well-stained nuclei; others were greatly swollen and degenerated. There was no evidence, however, that these cells had been carried to the spleen.

2. Large Hyaline Mononuclear Leucocytes.

Character and Reactions.—

There is some variation in *size* and depth of staining, similar to, but not so marked as, the variation in the endothelial cells, depending on their functional activity. They are usually from 10μ to 11μ, but may be as much as 15μ, when they approximate to the size of the young endothelial cells.

There is no variation in the *shape*, which is always round.

The *protoplasm* is much less abundant than that of the endothelial cell; the older forms show a multiple fine vacuolation. It stains more deeply than the endothelial protoplasm, light blue with Leishman's stain, bright red (and granular looking) with Saathoff's stain.

The *nucleus* is relatively large, and is usually placed on one side of the cell; it is kidney-shaped, oval, or round; it is much richer in chromatin, and has a coarser reticulum than the endothelial nucleus; there are several darkly-stained nodal points, and occasionally one or two small nucleoli can be seen. It stains a dark purple or blue with both Leishman's and Saathoff's stains. There is no evidence of nuclear division.

As already pointed out, the only absolute method of distinguishing between the large mononuclear leucocyte and the endothelial cell, is by the oxydase reaction. The large mononuclear leucocyte gives this reaction, although neither so rapidly nor so actively as does the polymorphonuclear

leucocyte. The dye usually is deposited first in the protoplasm opposite the hilum of the nucleus (*Fig.* 1).

In two cases a few cells were found slightly smaller than the ordinary large mononuclear leucocyte (but with similar staining reactions), with a central, relatively small, nucleus. These are sometimes classed as 'large lymphocytes' or as 'intermediate forms'; but as they give the oxydase reaction they must be included with the large hyaline mononuclear leucocytes.

Origin.—As has already been mentioned, the omental vessels have a large number of large mononuclear leucocytes (which tend to accumulate at the periphery), and many of these are found outside the small veins, having migrated through the wall. These cells correspond to the younger forms met with in the peritoneal fluid before the increase in size and functional activity have taken place. The oxydase reaction has not only clearly demonstrated the fact that these cells differ entirely from the endothelial cells, it has also confirmed Ehrlich's view that they originate in the adult bone-marrow.

Later Changes.—After entering the peritoneal cavity the cells increase in size, the nucleus becomes slightly larger and stains less deeply, the protoplasm increases in amount, the multiple fine vacuolation is often present. In the later stages the nucleus becomes irregular in shape and staining.

Phagocytosis of Bacteria by Large Mononuclear Leucocytes.—This is neither so early nor so extensive as the phagocytic activity of the endothelial cells. Thus, in *Cases III*, *VI*, *XIV*, *XV*, and *XIX*, although bacteria were present in the endothelial cells, none were found in the large mononuclear leucocytes. But in almost all the cases in which a positive culture was got from the peritoneal fluid, bacteria were present in the large mononuclear leucocytes, a notable exception being *Case XXII*, in which the bacterial invasion of the peritoneal cavity was of only three hours' duration.

Phagocytosis of Polymorphonuclear by Large Mononuclear Leucocytes.—This, again, is neither so early nor so extensive as that shown by the endothelial cells. It was not seen in any case in which no bacteria were found in the fluid, and in only three cases in which a positive culture was not obtained.

The ingested polymorphonuclear leucocytes were apparently normal in some cases; in others degenerative changes were apparent.

Clumping.—A tendency to clumping of the large, more mature forms was noticed in many cases, but as a rule this was not nearly so extensive as that shown by the polymorphonuclear leucocytes referred to later.

In all cases where clumping was present, the cells showed multiple fine vacuolation; in most of them phagocytosis to bacteria or polymorphonuclear leucocytes, or to both, was evident.

3. Polymorphonuclear Leucocytes with Fine Neutrophil Granules.

It is unnecessary to describe the character and staining reactions of this very definite type of cell.

Phagocytosis of Bacteria by Polymorphonuclear Leucocytes.—

Dudgeon and Ross[6] found that one hour after intraperitoneal injection of bacteria or non-bacterial substances, these cells began to take an important

part in peritoneal phagocytosis, and were, up to the death of the animal in fatal cases, the chief bacterial phagocytes.

The time at which phagocytosis commences depends not only on the virulence, but also on the number, of the bacteria.

Beattie[2] found that if actively virulent bacteria in small numbers are injected, a few are ingested by the polymorphonuclear leucocytes within four or five hours, but nine hours elapse before phagocytosis is well established. If the virulence of the bacteria is less, they are ingested sooner, thus suggesting that their activity must be impaired before being ingested. Again, if large numbers of actively virulent bacteria are injected, there is a more marked leucocytosis and a correspondingly early ingestion of bacteria, but the number in each cell is small and there are many not ingested.

Although in many of my cases it was impossible to give even an approximate estimate of the duration of the bacterial invasion, several interesting facts were noted which confirm these views. Thus in *Cases II, VIII, XI, XVI*, a few polymorphonuclear leucocytes (from 3 to 4 per cent) contained single bacteria, although none were found free in the fluid.

Again, in *Cases XIV, XIX*, about 5 per cent of the polymorphonuclear leucocytes contained single bacteria; a few free bacteria were seen in the fluid, but the culture was negative.

Cases X, XII (leaking appendix abscesses) afforded an interesting contrast in phagocytic activity. In both, the attempt at localization had failed, and there was a commencing spreading peritonitis; the number of bacteria which had found their way into the peritoneal cavity was large. In the former the leakage was of twelve hours' duration; the number of polymorphonuclear leucocytes was 817 per 1000, of which 202 contained numerous bacteria; in the latter the leakage was of eighteen hours' duration; the number of polymorphonuclear leucocytes was 840 per 1000, of which only 109 contained bacteria, and never more than two or three in each. The difference was probably due to the fact that the virulence of the bacteria in the latter case was much greater, and this explanation was borne out by the subsequent progress after operation. (*See under* PROGNOSIS, page 27.)

In the five cases of diffuse peritonitis, the dependence of the phagocytic activity on the virulence and duration of the bacterial invasion was well shown.

Thus in *Cases XIII, XX*, and *XXI*, although there was little difference in the number of polymorphonuclear leucocytes (836 per 1000), in *Case XXI* the number phagocytic to bacteria was 317, whereas in *Cases XIII* and *XX* it was 183 and 165 respectively. This difference was explained by the fact that the virulence of the bacteria in *Case XXI* was low, as was borne out by the subsequent progress after operation. (*See under* PROGNOSIS, page 28.)

In *Case XXIV*, in which the peritonitis was of eighteen hours' duration, the virulence of the organisms was low; but owing to the long duration of the irritation, the number of polymorphonuclear leucocytes was greater, viz., 931 per 1000. Of these, however, 315 contained bacteria, and the number of bacteria in each cell was very large (*Fig.* 9).

In *Case XXII* the virulence of the bacteria was very great, and although the duration of the invasion was only three hours, the number of polymorphonuclear leucocytes was very large (932 per 1000). Of this number, however, only 56 contained bacteria, and these were found singly in the cells. The number of free bacteria was very large (*Fig.* 5).

Examination of the peritoneal fluid sixty hours after the operation gave a remarkably clear demonstration of the beneficial effect of the removal of the source of the bacterial supply. A fair number of bacteria were still seen free, but most had been ingested by the various cells. The number of polymorphonuclear leucocytes had fallen to 764 per 1000, and of these 310 contained numerous bacteria (*Fig.* 6).

Degeneration of Polymorphonuclear Leucocytes.—This was seen in almost all cases in which a positive culture was got from the fluid (an exception was *Case XVIII*, in which the *Bacillus coli* growth was very feeble).

It was most marked in cases in which the bacterial invasion was extensive and of long duration (e.g., *Case XXIV*); but in *Case XXII* it was present, although the invasion was of only three hours' duration.

With two exceptions, it was not seen in a fluid from which a negative culture was got. One of these was *Case XIX*, where there was slight degeneration in the ingested cells; the other was the fluid got twenty days after operation in *Case XXIII*, in which most of the ingested cells were degenerated.

Clumping.—The polymorphonuclear leucocytes, like the mononuclear leucocytes, show a tendency to agglutination, but to a much greater extent. This is usually seen to a slight extent even in fluids from which a negative culture is got, but it is much more marked when the bacterial invasion is more acute. In *Case XXII*, where the invasion was of only three hours' duration, it was comparatively slight, but in the cases of longer duration, as *Cases V*, *XXIV*, it was very extensive. In most cases the clumped cells contain numerous bacteria and show signs of degeneration. Examination of the omentum in these cases shows that there is a very great tendency for accumulation of these cells on its surface.

Destiny.—The polymorphonuclear leucocyte may degenerate and break down in the peritoneal fluid, or this may take place after ingestion and digestion by the endothelial cells. It may be carried direct to the omentum and be ingested by the endothelial cells still unshed, or it may be carried by the lymphatic vessels to the lymphatic glands.

Polymorphonuclear Leucocytes with Coarse Eosinophil Granules.—

Beattie[2] found that after peritoneal injections these cells played no important part in the reaction; others have found that under the reaction of certain chemiotactic stimuli, they may be called out in much larger numbers than the finely granular neutrophil variety.

In only one case (*Case X*) have I seen even a fair number of these cells; in most of the fluids they were almost entirely absent. I have accordingly not enumerated them separately, but have included them along with the finely granular neutrophil variety as 'polymorphonuclear leucocytes.'

4. Lymphocytes.

Character and Reactions.—

These cells vary in *size* from 6μ to 8μ, and although it is difficult to fix the upper limit by ordinary stains, as the larger ones may approach to the character of the large mononuclear leucocytes, the oxydase reaction has shown that there are no transitions.

The *protoplasm* is very scanty; it stains in the same way as the large mononuclear leucocyte, but a little more deeply.

The *nucleus* is relatively very large, usually round, but sometimes oval or with a very slight lateral depression; it is central. It is exceedingly rich in chromatin, and thus stains more deeply than the large mononuclear nucleus.

This cell is not phagocytic, shows no degenerative changes, is not ingested by other cells, and has no tendency to clumping.

Origin.—These cells come from the blood and from the lymphatic vessels (where they are numerous in health), and, especially in the more chronic cases, they probably are also derived from the increased lymphoid tissue found in the omentum and in the submucous layer of the appendix.

Function.—They take little or no part in acute inflammation, but if there has been a mild irritant acting over a long period, they are found in large numbers in the peritoneal fluid. Thus, in *Case VII* (catarrhal appendicitis) there were 550 per 1000, owing to the irritation of several recent previous attacks; in *Case VI* (partially localized peritonitis due to perforation of duodenal ulcer) there were 208 per 1000 in the serous fluid in the general peritoneal cavity, owing to many previous recent 'pin-point' perforations; in *Case XVI* (tubo-ovarian abscess) there were 350 per 1000 in the serous pelvic fluid, owing to the long duration of the infective focus; in *Case XXIII* (localized appendix abscess) the fluid from the peritoneal cavity, twenty days after the removal of the appendix and drainage of the abscess cavity, showed 431 lymphocytes per 1000 cells.

Destiny.—They are probably carried back through the lymphatic vessels to the lymphatic glands.

Mast Cells with Granules showing Metachromatic Staining.—These were only occasionally seen, and their rarity in the exudate is confirmatory of the view that they take no part in the active processes of inflammation.

Red Blood-Corpuscles.—In several cases red corpuscles were found ingested by endothelial cells.

It was so extremely difficult to obtain the fluid in every case without an occasional contamination with blood from the abdominal wound, that I have not enumerated these cells when present in the fluid.

The Cells of the Normal Peritoneal Fluid.—I examined the fluid from the normal peritoneal cavity in several cases in which a laparotomy was performed for various conditions. It was serous in character, very small in amount, and contained very few cells.

The cells were almost entirely *endothelial cells* of varying sizes, shapes, and depths of staining. Most of them were of the young, small, deeply staining variety which may closely resemble the large mononuclear leucocytes. Some were larger, with vacuolated protoplasm, and showing active nuclear and protoplasmic division. A few degenerated endothelial cells with very lightly staining nuclei and very indefinite, coarsely vacuolated protoplasm were also seen.

I saw no *polymorphonuclear leucocytes*, either finely or coarsely granular, and only an occasional *lymphocyte*, but a few *large mononuclear leucocytes* (with no vacuolation) were found in each case.

No phagocytosis of cells was observed.

PERITONITIS IN THE HUMAN SUBJECT.

Peritonitis in the human subject differs in many respects from that induced experimentally in animals, especially as regards the tendency to localization.

In the case of a perforation of a gastric or duodenal ulcer, we may indeed have a free-spreading peritonitis which rapidly becomes general in its distribution; but even in this condition there is a tendency for the very rapid formation of adhesions which may, to a certain extent, restrict its progress. Thus in *Case VI* the 'peritonitis' was limited to the right half of the abdominal cavity (which contained a large quantity of very turbid fluid) by the formation of adhesions between the loops of the intestines. In the left side of the abdominal cavity there was a fair quantity of serous fluid. In the majority of cases of intra-abdominal inflammation there is, however, a very definite attempt at localization, the success of which depends on various factors. The position of the primary focus may be of importance—e.g., a gonorrhœal infection of the Fallopian tube (*Case XVI*) rarely gives rise to a spreading peritonitis, but is usually well localized in the pelvis; or again, inflammation of an appendix situated behind the cæcum is much less likely to give rise, at least in the early stage, to a spreading peritonitis than if the organ is in the iliac fossa, as a retrocæcal abscess is usually much better shut off from the general peritoneal cavity than an iliac abscess. Former less severe attacks of appendicitis, by giving rise to adhesions, may help to localize the peritonitis which results from an acute perforative attack.

Again, the method by which a well localized inflammatory focus (such as a localized appendix abscess) in the peritoneal cavity may give rise to a spreading peritonitis, varies. In two of my cases (*Cases X, XII*) the adhesions, which had for several days limited the abscess, gave way slightly at one point, and allowed the pus to leak into the general peritoneal cavity. The result was that the ensuing peritonitis did not immediately become general, but was of a slowly progressive character. In four cases (*XX, XXI, XXII, XXIV*) the adhesions limiting the abscess suddenly gave way, allowing a comparatively large quantity of pus to pour into the general peritoneal cavity, thus giving rise to a peritonitis which only required time in order to become absolutely general. In *Case XIII* the pus inside the appendix was suddenly poured out through a large perforation into the general peritoneal cavity without the preliminary formation of an abscess outside the appendix.

The virulence of the causal organism plays an important part in the success or otherwise of the attempts at localization; and in those cases where pus is suddenly given access to the general peritoneal cavity, the severity of the ensuing peritonitis depends not only on the quantity, but also on the virulence, of the bacterial invasion.

As has already been pointed out, it is often impossible in the human

subject to give even an approximate estimate of the duration of the bacterial invasion before the operation; accordingly it would serve no useful purpose to attempt to summarize in tabular form the relative proportion of the various cells according to the duration.

It will be more useful to give a short summary of the essential features of the various types of cases in this series, and, in detail, the various types of peritoneal exudates found in them, special reference being made to their prognostic significance.

APPENDICITIS: EIGHTEEN CASES.

Type I. Case VII, Catarrhal Appendicitis.—The appendix, which was stenosed at the base, was full of fæcal material and was in a condition of catarrhal inflammation, there being a polymorphonuclear leucocytic infiltration of the mucosa.

Type II. Cases XVII, XVIII, XIX, Acute Suppurative Appendicitis—in which the pus was confined to the lumen of the appendix. In none of these was there a gross perforation, but in *Case XIX* bacteria were found free in the peritoneal fluid, and in *Case XVIII* a growth of *Bacillus coli* was obtained from the peritoneal fluid.

Type III. Cases I, IV, XXIII, II, VIII, XI, XIV, Acute Suppurative Appendicitis; Perforation; Localized Abscess.—In the first three of these no bacteria were found in the peritoneal fluid; in the next three a few were found in the cells; and in the last a few were found free in the fluid. In none of them was a positive culture obtained from the peritoneal fluid.

Type IV. Cases X, XII, Acute Suppurative Appendicitis; Perforation; Leaking Abscess.—In both these cases a growth of *Bacillus coli* was obtained from the peritoneal fluid.

Type V. Cases XX, XXI, XXII, XXIV. Acute Suppurative Appendicitis; Perforation; Ruptured Abscess; Free Spreading Peritonitis.—In all of these a growth of *Bacillus coli* was obtained from the peritoneal fluid.

Type VI. Case XIII, Acute Suppurative Appendicitis; Perforation; Free Spreading Peritonitis.—A growth of *Bacillus coli* was obtained from the peritoneal fluid.

Pus from the Focus of Infection.—This was examined in every case. In *Case VIII* a mixed growth of *Bacillus coli* and *Staphylococcus pyogenes albus* was got, in all the others the growth was *B. coli* alone. Films of the pus showed that there was little variation in the different cases; the vast majority of the cells (about 98 per cent) were polymorphonuclear leucocytes in all stages of degeneration, many of them containing numerous bacteria. About 2 per cent were large mononuclear leucocytes, showing degenerative changes and containing bacteria. In the abscess cases a few degenerated endothelial cells were seen, many of which contained numerous bacteria, and some degenerated polymorphonuclear leucocytes. Free bacteria were usually plentiful.

The Various Types of Peritoneal Exudate.—In all cases of intra-abdominal inflammation, the peritoneal fluid present in the normal abdomen increases in quantity and changes in character.

Bacteria.—In five cases no bacteria were found in the fluid; in three, a few bacteria were present in the polymorphonuclear leucocytes, but none free; in two, a few bacteria were found free, but the culture was negative; in three, a weak *Bacillus coli* culture was obtained; and in the remaining five cases there was a vigorous *B. coli* growth. No cultures were made from the omentum, so that I had no opportunity of confirming the researches of Dudgeon and Sargent on the important part played by the *Staphylococcus pyogenes albus* in peritonitis.

A.—In those cases in which the *primary focus is well localized*, the naked-eye appearance of the exudate may to a certain extent give an indication of the severity of the bacterial invasion and of the resulting cellular reaction.

Serous.—The fluid is very scanty, and contains very few cells; there are few polymorphonuclear leucocytes, many endothelial cells, and many lymphocytes; there are no bacteria.

Almost Clear or *Slightly Turbid.*—The fluid is either scanty or in fair quantity; but may, if the focus of infection is of long duration, be more abundant. The cells are not numerous; the polymorphonuclear leucocytes vary from 456 to 653; the large mononuclear leucocytes from 152 to 223; and the endothelial cells from 336 to 101 per 1000; phagocytosis to cells is present; there are no free bacteria, but a few single bacilli may be found in the polymorphonuclear leucocytes (*Fig.* 7).

Turbid.—The fluid is more abundant, and the cells more numerous; the polymorphonuclear leucocytes are more numerous, varying from 729 to 764, the large mononuclear leucocytes vary from 148 to 107, the endothelial cells are fewer, varying from 92 to 68 per 1000; there is no degeneration of the polymorphonuclear leucocytes, but slight clumping of these cells and of the large mononuclear leucocytes is seen; phagocytosis to cells and bacteria is more marked; a few bacteria are found either free or in the cells.

B.—In the two cases of *leaking abscess* one could not make any deductions from the naked-eye character of the peritoneal fluid. The fluid in *Case X* was thick and creamy, and contained very many cells; but there were only 817 polymorphonuclear leucocytes, whereas the very turbid fluid in *Case XII* had 840 polymorphonuclear leucocytes per 1000. In both, the endothelial cells were comparatively few, there was degeneration of polymorphonuclear leucocytes, and clumping of both polymorphonuclear and large mononuclear leucocytes. In both, a weak *B. coli* growth was got from the fluid, but phagocytosis, both to bacteria and cells, was much more marked in *Case X* than in *Case XII* (*Fig.* 4).

C.—In the cases of *free spreading peritonitis* the consistence of the fluid gave some indication of the duration of the bacterial invasion, but it was impossible to make any reliable deductions from the naked-eye appearance of the fluid as to its cellular character or significance.

In *Cases XIII, XXII* the fluid was merely *turbid*, but its cellular character presented wide differences.

Thus, in *Case XIII* there were 861 polymorphonuclear leucocytes (183 of which showed very active phagocytosis to bacteria) and 25 endothelial cells per 1000; whereas in *Case XXII* there were 932 polymorphonuclear leucocytes, only 56 of which showed very slight phagocytosis to bacteria, and only

5 endothelial cells per 1000. In the latter case the number of free bacteria was very great (*Fig.* 5).

In *Cases XXI, XX* the fluid was *very turbid*, or '*almost purulent.*' These cases presented important differences in their cellular character. Thus, in *Case XXI* there were only 838 polymorphonuclear leucocytes, 317 of which showed very active phagocytosis to bacteria, and 20 endothelial cells per 1000; whereas in *Case XX* there were 876 polymorphonuclear leucocytes, only 165 of which showed phagocytosis to bacteria, and only 4 endothelial cells per 1000. Thus the fluid in this case, although 'almost purulent,' resembles the turbid fluid in *Case XIII.*

Lastly, *Case XXIV* was one in which the very large quantities of *thick creamy pus* represented a late stage in the peritoneal reaction. There were 931 polymorphonuclear leucocytes, 315 of which showed very active phagocytosis to bacteria; there were no endothelial cells present, and only 63 large mononuclear leucocytes per 1000. There was marked degeneration of the polymorphonuclear leucocytes, and clumping of these cells and of the large mononuclear leucocytes. Many bacteria were present free in the fluid (*Fig.* 9).

D.—In two of the above cases fluid was obtained some time after the operation, during recovery.

Case XXII B.—The fluid from the pelvis sixty hours after the operation was large in amount and only slightly turbid in consistence. It presented a very marked contrast to that obtained at the operation. The polymorphonuclear cells had fallen from 932 to 764 per 1000, 310 of which, however, showed very active phagocytosis to bacteria; the large mononuclear leucocytes had risen from 45 to 191, and the endothelial cells had risen from 5 to 28. Phagocytosis to cells was now well established, and clumping of the polymorphonuclear leucocytes was extensive. The number of free bacteria had diminished greatly (*Fig.* 6).

Case XXIII B.—This fluid, obtained twenty days after the first operation, shows the condition in a peritoneal cavity which has almost completely recovered from the original focus of inflammation. The fluid was serous, and scanty in amount; the cells were very few; it differed from the serous fluid got from the peritoneal cavity in *Case VII* in two important points—namely, the presence of a fairly large number of degenerated endothelial cells, and the ingestion of degenerated polymorphonuclear leucocytes in healthy and degenerated endothelial cells (*Fig.* 8).

PERFORATED GASTRIC OR DUODENAL ULCER: FOUR CASES.

Case VI.—A partially localized peritonitis of thirteen hours' duration due to the perforation of a duodenal ulcer.

EXUDATE.—A fair quantity of *serous* fluid in the left side of the abdominal cavity. This exudate resembles in many respects that found in *Case I*—absence of bacteria, number of polymorphonuclear leucocytes equal to combination of large mononuclear leucocytes and endothelial cells, a fair number of endothelial cells containing polymorphonuclear leucocytes, no degeneration of polymorphonuclear leucocytes. In this case, however, owing to the many previous 'pin-point' perforations, the proportion of lymphocytes was much higher, viz., 208 per 1000.

PROGNOSIS.—The prognosis in this case could not be based on the character of the fluid, which was protective or reactionary, but depended on the conditions found in the right half of the abdomen.

Case III.—A diffuse general peritonitis of five and a half hours' duration due to the perforation of a pyloric ulcer.

EXUDATE.—A large quantity of *turbid* fluid in the general peritoneal cavity. This exudate corresponds in many respects with that found in *Case XVIII*, although the character and duration of the bacterial invasion and the clinical symptoms were entirely different. In both a few bacteria were found free; the number of the polymorphonuclear leucocytes (751, 756) and also the number of these cells containing bacteria (56, 62) were almost identical; there was slight clumping, but no degeneration, of the polymorphonuclear leucocytes. In this case the number of endothelial cells was larger, and more contained bacteria; but, on the other hand, fewer contained polymorphonuclear leucocytes.

Unfortunately no culture was taken; but the bacteria were arranged in bundles like sarcinæ.

PROGNOSIS.—Immediate examination of the exudate showed that the reactive forces were well developed and that no drainage was called for; lavage, however, was necessitated by the presence of particles of food in the peritoneal cavity. A very favourable prognosis was given.

PROGRESS.—Rapid and uninterrupted.

Case XV.—A diffuse general peritonitis of four hours' duration due to the perforation of a malignant gastric ulcer.

EXUDATE.—A large quantity of *very turbid* fluid in the general peritoneal cavity, from which a growth of *Sarcina ventriculi* was got. This exudate differed from that in *Case III* in several respects; the number of free bacteria was much greater; the number of polymorphonuclear leucocytes (912) was much greater, although fewer contained bacteria; the number of endothelial cells was much smaller, and very few contained bacteria. Thus, although the bacterial invasion was of shorter duration, the peritoneal conditions were less favourable, owing probably to the greater virulence of the organism. This was borne out by the patient's condition before operation, which was much worse (collapse, pulse 118, temperature 97·4°) than in *Case III* (no collapse, pulse 104, temperature 99·6°.)

PROGNOSIS.—A guarded prognosis was given, partly because phagocytosis to bacteria and cells had not been well established, and partly because the source of infection could not be effectively closed.

PROGRESS.—This was uninterrupted, but not so rapid as in *Case III*.

Case V.—A diffuse general peritonitis of thirty-six hours' duration, due to the perforation of a pyloric ulcer.

EXUDATE.—An enormous quantity of *turbid* fluid, in which were many masses of fibrinous material in the general peritoneal cavity, from which a growth of *Sarcina ventriculi* and Oppler-Boas bacillus was got. This fluid consisted chiefly of enormous numbers of bacteria; owing to the very extensive clumping of the cells few were found free in the fluid, and the differential count was thus valueless. All the polymorphonuclear leucocytes seen were degenerated; there was little phagocytosis to bacteria and none to cells.

PROGNOSIS.—The moribund condition of the patient and the hopelessness of the prognosis were thus confirmed by the demonstration of the failure of the reactive forces to overcome the bacterial invasion.

PROGRESS.—After a temporary improvement for thirty-six hours, due to the escape of large quantities of fluid through a suprapubic drainage tube, the patient's condition became very rapidly worse, and he died forty-eight hours after operation.

TUBO-OVARIAN ABSCESS: ONE CASE.

Case XVI.—Double tubo-ovarian abscess of one week's duration, with acute pelvic pain of eighteen hours' duration.

EXUDATE.—A small quantity of *serous* fluid in the pelvis. This exudate resembled in many respects that found in *Case II*; in both, no bacteria were found free, there were a fair number of polymorphonuclear leucocytes, a few of which contained single bacteria; there were a fair number of endothelial cells, several of which contained polymorphonuclear leucocytes. The proportion of lymphocytes (350) in this case was much larger, owing to the long duration of the focus of infection.

PROGNOSIS.—Examination during the operation showed that the fluid was protective in character, and as the focus of infection was removed, a good prognosis was given. Some pus spilt during removal was examined and found to contain gonococci (a growth was got later from the abscess), and a small gauze drain was introduced, probably quite unnecessarily.

PROGRESS.—So far as the abdominal condition was concerned the progress was rapid, but a left basal pneumonia caused great anxiety during convalescence.

HERNIA: ONE CASE.

Case IX.—A femoral hernia, strangulated for six hours, incompletely reduced thirty hours before operation.

EXUDATE.—A large quantity of *turbid* fluid in the general peritoneal cavity.

This exudate resembled in many respects that found in *Case XVIII*; in both a few bacteria were found free, the number of polymorphonuclear leucocytes was large, and a fair number contained bacteria; there was some phagocytosis to cells, and no degeneration of polymorphonuclear leucocytes.

PROGNOSIS.—The exudate was clearly protective in character; but owing to the collapsed condition of the patient, whose age was 72, and to the possibility of the bowel having been seriously damaged during reduction, a guarded prognosis was given.

PROGRESS.—From the tenth to twentieth day there was elevation of pulse and temperature, with considerable abdominal discomfort; otherwise the progress was uneventful.

THE PROGNOSTIC VALUE OF AN EXAMINATION OF THE EXUDATE.

A.—In those cases in which the *primary focus of inflammation is well localized*, the microscopic and cultural examination of the peritoneal exudate shows that, while there are minor variations in the character of the fluid,

in its consistence, in its amount, in the relative number of the cells, and in the presence or absence of bacteria and of bacterial phagocytosis, in all cases the outstanding feature of the fluid was its reactionary or protective nature. But one could not base the prognosis on this, owing to the presence of the abscess, with the dangers directly due to it—septicæmia, pyæmia, subdiaphragmatic abscess, empyema, etc. For example, in *Cases II, IV* there was marked toxæmia, with high temperature and very rapid pulse before the operation, although in both cases the character of the exudate was most favourable.

In those cases in which the pus was confined to the lumen of the appendix, and in which it was thus possible to remove entirely the focus of infection, one was able to give a more definitely favourable prognosis, as these attendant dangers were to a large extent removed.

In the three cases of this kind the peritoneal exudate was protective in character, and the progress after operation (primary closure) was uninterrupted; though in *Case XIX* the elevation of pulse and temperature, which was very marked before operation, persisted for five days.

B.—In the two cases of *leaking abscess*, examination of the exudate, while not giving an absolutely reliable guide to the prognosis, owing to the presence of the abscess with its attendant dangers, gave one a very clear indication as to the success of the defensive forces combating the bacterial invasion of the peritoneal cavity.

In *Case X*, the defensive forces of the peritoneal cavity had evidently gained the upper hand twelve hours after the commencement of the leakage; 202 of the 817 polymorphonuclear leucocytes contained numerous bacteria, which were also present in many large mononuclear leucocytes and endothelial cells; 35 of the 75 endothelial cells contained numerous polymorphonuclear leucocytes (*Fig.* 4). Although this patient was very ill before operation (pulse 118) a good prognosis was given, the accuracy of which was borne out by the rapid and uninterrupted progress after operation.

In *Case XII* the peritoneal exudate presented a much less favourable aspect. Although eighteen hours had elapsed since the commencement of the leakage, only 109 of the 840 polymorphonuclear leucocytes contained bacteria, and never more than two or three in each; only a few of the large mononuclear leucocytes and endothelial cells contained bacteria, and only 13 of the 60 endothelial cells contained polymorphonuclear leucocytes.

Thus, although the patient was apparently not so ill (pulse 96) as the other, a less favourable prognosis was given. The progress after operation confirmed this, as for five days there was considerable elevation of the pulse and temperature.

C.—In the four cases of ruptured abscess with *free spreading peritonitis*, examination of the peritoneal exudate gave most valuable prognostic information, as in these cases the danger of complications due to the abscess was trivial compared to the danger of the peritonitis. The prognostic value of the examination was even greater in *Case XIII*, in which the appendix had ruptured direct into the peritoneal cavity, as the focus of infection was completely removed at the operation.

The relation of the examination of the exudate to the prognosis and

progress after operation in these five cases will now be given, taking the cases in the order of severity.

Case XXI.—The peritoneal exudate in this case was very turbid and abundant; a growth of *B. coli* was got from the fluid, in which also were many free bacteria; 317 of the 838 polymorphonuclear leucocytes contained numerous bacteria, and 8 of the 24 endothelial cells contained polymorphonuclear leucocytes; degeneration of the polymorphonuclear leucocytes was seen only in those ingested.

Although this patient (who had a pelvic abscess of two and a half days' duration which had ruptured seven hours before operation) was extremely ill, toxæmic, pulse 126, temperature 101°, a very favourable prognosis was given, as evidently the reactive forces of the peritoneum were quite able to resist the infective forces of the bacterial invasion.

Progress after the operation was very rapid; within twenty-four hours the acute abdominal pain had almost completely disappeared, and the pulse and temperature were normal on the second day. A slight rise of temperature from the eleventh to the thirteenth day, which disappeared with the discharge of some *B. coli* pus from the vagina, was due directly to the local pelvic condition and not to the general peritoneal condition.

Case XIII.—The peritoneal exudate was turbid and abundant; a growth of *B. coli* was got from the fluid, in which also were many free bacteria; 183 of the 861 polymorphonuclear leucocytes contained numerous bacteria; and 4 of the 25 endothelial cells contained polymorphonuclear leucocytes; degenerative changes were seen in both free and ingested polymorphonuclear leucocytes.

Thus, although this patient was not toxæmic and had had practically no symptoms before the perforation took place (six hours before operation), the peritoneal condition was not so favourable as that found in *Case XXI*; but at the same time a favourable prognosis was given, as it was thought that the reactive forces of the peritoneum were able to resist the infective forces, especially as there was no abscess cavity left, with its attendant dangers.

Progress after the operation was rapid; but for ten days the pulse and temperature remained elevated, and there were vague abdominal pains. Thus the success of the reactive forces was not so certain as in *Case XXI*, and hung longer in the balance.

Case XX.—The peritoneal exudate was very turbid (almost purulent) and abundant; a growth of *B. coli* was got from the fluid, in which also were many free bacteria. There were 876 polymorphonuclear leucocytes, of which only 165 contained bacteria (numerous), and only 4 endothelial cells, one of which contained a polymorphonuclear leucocyte; there were 26 degenerated endothelial cells; degenerative changes were seen in the polymorphonuclear leucocytes.

The condition of this patient, who had a retrocæcal abscess of three and a half days' duration which had ruptured seven hours before operation, resembled that of *Case XXI*—namely, toxæmia, pulse 128, temperature 100°—the only difference being a greater degree of distention. The peritoneal condition, however, as revealed by the examination of the exudate, was much less favourable (much less phagocytosis to bacteria and cells, fewer endothelial

cells, more extensive degeneration of polymorphonuclear leucocytes, and more degenerated endothelial cells), but at the same time was considered satisfactory, and a favourable prognosis was accordingly given.

Progress after operation was neither rapid nor uninterrupted, although the acute abdominal pain had almost entirely disappeared within twenty-four hours. The temperature remained elevated for five days, it rose again from the seventh to the ninth day, and again from the sixteenth to the twentieth; on the twenty-second day there was a severe rigor and it rose to 105°, and did not become normal until the twenty-sixth day. The only physical signs which accompanied these elevations of temperature were slight abdominal discomfort, and tenderness on pelvic examination. Thus in this case, as in *Case XIII*, the success of the conflict between the reactive and infective forces was neither so rapid nor so certain as in *Case XXI*.

Case XXIV.—The peritoneal exudate was thick and creamy, and enormous in amount; a growth of *B. coli* was got from the fluid, in which also were many free bacteria. There were 931 polymorphonuclear leucocytes, of which 315 contained very numerous bacteria; there were no endothelial cells; degeneration of the polymorphonuclear leucocytes was very extensive (*Fig.* 9).

This patient was not so desperately ill as one would have expected from the duration of the symptoms—rupture of a three days' abscess eighteen hours before operation—and from the amount and naked-eye appearance of the fluid. This was explained by the examination of the fluid, which showed that the reactive forces were acting most vigorously, the phagocytic activity of the polymorphonuclear leucocytes far exceeding that shown in *Cases XIII*, *XX*, and *XXI*.

The relatively large proportion of polymorphonuclear leucocytes and the complete absence of the endothelial cells was due to the long duration (eighteen hours) of the bacterial invasion, which also explained the extensive degeneration present. A very favourable prognosis was given.

Progress after the operation was rapid and uninterrupted.

Case XXII.—The peritoneal exudate was turbid and abundant; a *B. coli* growth of exceptional strength was got from the fluid, in which were a very large number of free organisms. There were 932 polymorphonuclear leucocytes, only 56 of which contained bacteria (single); there were only 45 large mononuclear leucocytes; and 5 endothelial cells, 2 of which contained polymorphonuclear leucocytes; degenerative changes in the polymorphonuclear leucocytes were well marked (*Fig.* 5).

The clinical condition of this patient, who had, only three hours before operation, ruptured a pelvic abscess of two and a half days' duration, resembled that of *Case XIII*, but the examination of the exudate showed that he was in a much more precarious condition. The strength of the culture, the very large number of extracellular bacteria, the scarcity of the large mononuclear leucocytes and endothelial cells in so early a case, the early degeneration of the polymorphonuclear leucocytes, and especially the very poorly developed phagocytic activity of the latter, compelled one to give a very unfavourable prognosis.

Progress after the operation: there was no apparent improvement in the patient's condition; in fact his symptoms became worse. The pulse was

Case	Condition	Peritoneal Exudate			
		Character	Quantity	Culture	Bacteria
VII	Catarrhal Appendicitis	Serous	Very scanty	Negative	None
I	Suppurative Appendicitis: Loc. Abscess	Almost clear	Scanty	Negative	None
XXIII	Suppurative Appendicitis: Loc. Abscess	Slightly turbid	Fair	Negative	None
XVII	Suppurative Appendicitis	Slightly turbid	Fair	Negative	None
IV	Suppurative Appenditis: Loc. Abscess	Slightly turbid	Large	Negative	None
II	Suppurative Appenditis: Loc. Abscess	Almost clear	Scanty	Negative	A few in P.
VIII	Suppurative Appendicitis: Loc. Abscess	Slightly turbid	Large	Negative	A few in P.
XI	Suppurative Appendicitis: Loc. Abscess	Turbid	Fair	Negative	A few in P.
XIX	Suppurative Appendicitis	Turbid	Fair	Negative	A few free
XIV	Suppurative Appendicitis: Loc. Abscess	Turbid	Fair	Negative	A few free
XVIII	Suppurative Appendicitis	Turbid	Large	Positive	A few free
X	Suppurative Appendicitis: Leaking Abscess	Creamy	Large	Positive	Some free
XII	Suppurative Appendicitis: Leaking Abscess	Very turbid	Large	Positive	Some free
XXI	Suppurative Appendicitis: Diffuse Peritonitis	Very turbid	Large	Positive	Many free
XIII	Suppurative Appendicitis: Diffuse Peritonitis	Turbid	Large	Positive	Many free
XX	Suppurative Appendicitis: Diffuse Peritonitis	Very turbid	Large	Positive	Many free
XXIV	Suppurative Appendicitis: Diffuse Peritonitis	Creamy	Very large	Positive	Many free
XXII	Suppurative Appendicitis: Diffuse Peritonitis	Turbid	Large	Positive	Very many free
XXII B	Sixty hours after operation in Case XXII	Slightly turbid	Large	None taken	Some free
XXIII B	Twenty days after operation in Case XXIII	Serous	Scanty	Negative	None
VI	Perforated Duodenal Ulcer	Serous	Fair	Negative	None
III	Perforated Gastric Ulcer	Turbid	Large	None taken	A few free
XV	Perforated Gastric Ulcer	Very turbid	Large	Positive	Many free
V	Perforated Gastric Ulcer	Turbid	Very large	Positive	Very many free
XVI	Tubo-ovarian Abscess	Serous	Scanty	Negative	A few in P.
IX	Femoral Hernia	Turbid	Large	None taken	A few free

* Many bacteria in each P.

P.—Polymorphonuclear leucocyte.
L M.—Large mononuclear leucocyte.
L.—Lymphocyte.
E.—Endothelial cell.
D E.—Degenerated endothelial cell.
B.—Bacteria.

Differential Count					Phagocytosis of Bacteria			Phagocytosis of Leucocytes		Degeneration	Clumping	
P	L M	E	D E	L	P with B	L M with B	E with B	E with P	L M with P	Of P	Of P	Of L M
50	76	320	4	550	—	—	—	—	—	—	—	—
456	152	318	18	56	—	—	—	12	—	—	—	—
591	195	163	—	51	—	—	—	26	—	—	—	—
624	176	178	3	19	—	—	—	16	—	—	—	—
648	170	83	68	31	—	—	—	11	—	—	—	—
473	219	195	25	88	17	—	—	8	—	—	—	—
653	223	81	20	23	19	—	—	7	—	—	—	—
760	107	92	20	21	26	—	—	33	2	—	Slight	Slight
729	148	68	10	45	42	—	2	24	2	Very slight	Slight	Slight
764	146	76	2	12	37	—	3	18	1	—	Slight	Extensive
756	128	88	8	20	62	4	6	16	2	—	Slight	Slight
817	90	75	7	11	202*	16	27	35	2	Yes	Moderate	Slight
840	85	60	5	10	109†	6	5	13	1	Yes	Moderate	Moderate
838	105	20	4	33	317*	16	7	8	—	Yes	Moderate	Moderate
861	102	25	2	10	183*	17	6	4	2	Yes	Moderate	Moderate
876	77	4	26	17	165*	7	2	1	1	Yes	Moderate	Moderate
931	63	—	—	6	315*	14	—	—	3	Yes	Extensive	Moderate
932	45	5	—	18	56†	—	—	2	—	Yes	Slight	—
764	191	28	2	15	310*	58	28	12	10	Yes	Extensive	Moderate
93	219	223	34	431	—	—	—	24	—	Slight	—	—
318	268	186	20	208	—	—	—	13	—	—	—	—
751	34	174	22	19	56	—	48	2	—	—	Slight	—
912	50	15	9	14	37	—	2	3	—	—	Moderate	Moderate
196	320	250	151	83	37	25	31	—	—	Yes	Extensive	Moderate
353	156	110	28	350	14	—	—	8	—	—	—	—
772	138	40	24	26	57	—	6	5	—	—	—	—

† Few bacteria in each P.

In Case VII the large number of L (550) is due to several recent previous attacks.
In Case VI ,, ,, L (208) is due to previous 'pin-point' perforations.
In Case VI ,, ,, L (350) is due to long duration of focus of infection.

very rapid and irregular, the temperature was elevated, there was persistent vomiting and hiccough, while the distention was so great as to suggest intestinal obstruction; the gauze drain was therefore removed sixty hours after the operation, and a rubber tube introduced into the pelvis.

Fluid from the Pelvis.—Sixty hours after operation this was less turbid than the original exudate, and abundant; no culture was made, but there was only a fair number of free bacteria present. There were only 764 polymorphonuclear leucocytes, of which 310 contained bacteria (numerous); there were 191 large mononuclear leucocytes, of which 58 contained bacteria (numerous), and 10 contained polymorphonuclear leucocytes; there were 28 endothelial cells, all of which contained bacteria (numerous), and 12 contained polymorphonuclear leucocytes (*Fig.* 6).

Although there was absolutely nothing in the patient's condition to indicate any improvement, a favourable prognosis was now given, as examination of this fluid showed that the reactive forces were now well developed, very active and extensive phagocytosis to bacteria and cells being present. The tube was withdrawn, as the fluid was now clearly defensive in character.

Progress continued. Although on the sixth day flatus was passed, and on the following day the bowels moved, it was not until the fourteenth day that the pulse and temperature became normal, and the pain and distention in the upper half of the abdomen disappeared.

Conclusions regarding Prognosis in Cases of free Spreading Peritonitis.

1. The number of extracellular bacteria present indicates approximately the amount of the bacterial invasion, the virulence of which is also shown by the vigour of the culture.

2. The relative number of extracellular and intracellular bacteria, and the number of bacteria in each phagocyte, give an indication of the relative powers of the reactive and infective forces.

3. Phagocytosis to cells, when present, is a favourable sign, but is not so important as phagocytosis to bacteria.

4. The duration of the bacterial invasion must always be borne in mind when considering the significance of the amount of phagocytosis to bacteria, the relative number of the various cells, and the amount of degeneration.

Thus, one does not expect extensive bacterial phagocytosis within the first few hours, but looks for it in the later stages. Again, a relatively large proportion of polymorphonuclear leucocytes is to be expected in cases of long duration; but in early cases one would like to see a fair proportion of large mononuclear leucocytes and endothelial cells. And, lastly, degeneration of the polymorphonuclear leucocytes, if seen within a few hours of the invasion, is an unfavourable sign, but if present in the later stages need not give great anxiety.

THE VALUE OF AN IMMEDIATE EXAMINATION OF THE EXUDATE DURING OPERATION; ITS BEARING ON THE QUESTION OF PERITONEAL DRAINAGE.

The prognostic value of an examination of the exudate, whether during or soon after the operation, has already been discussed, and the value of the

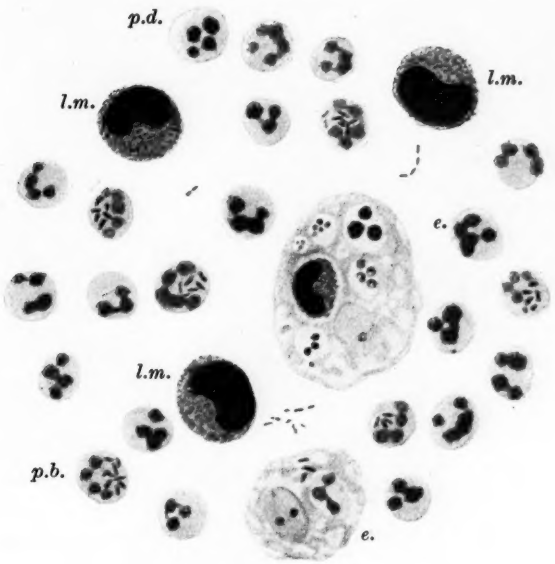

FIG. 4.—*Case X.* APPENDICITIS: LEAKING ABSCESS.
Duration of symptoms, 56 hours.

Film of pelvic pus, showing: (i) Relative proportion of different cells; (ii) Polymorphonuclear leucocytes with ingested bacteria (*p.b.*); (iii) Polymorphonuclear leucocytes showing degenerative changes (*p.d.*); (iv) Two endothelial cells (*e*), one of them showing vacuolation of protoplasm, ingestion of five polymorphonuclear leucocytes in varying stages of degeneration in digestive vacuoles, and ingestion of a large mononuclear leucocyte; (v) Free bacteria; (vi) Large mononuclear leucocytes (*l.m.*).

Stain.—Pyronin methyl-green (Saathoff).

FIG. 5.—*Case XXII.* APPENDICITIS: SPREADING PERITONITIS.
Duration of symptoms, 3 hours.

Film of peritoneal fluid, showing: (i) Relative proportion of different cells; (ii) *B. coli* in large numbers free, some clumping; (iii) Degenerated polymorphonuclear leucocytes (*d.p.*); (iv) One polymorphonuclear leucocyte containing a *B. coli* (*p.*).

Stain.—Pyronin methyl-green (Saathoff).

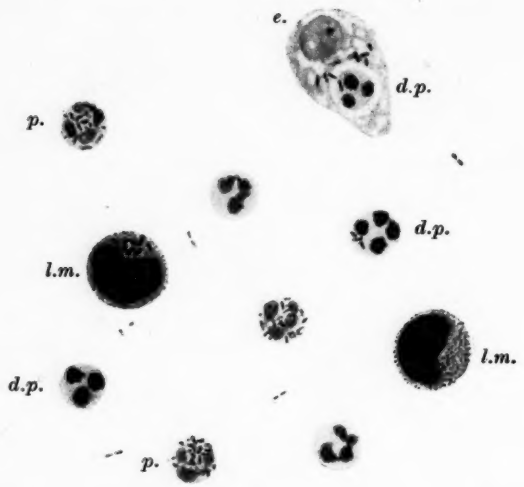

FIG. 6.—*Case XXII B.* APPENDICITIS: SPREADING PERITONITIS.
Sixty hours after operation.

Film of peritoneal fluid, showing: (i) Relative proportion of different cells; (ii) Bacteria, mostly ingested; (iii) Degeneration of polymorphonuclear leucocytes (*d.p.*); (iv) Ingestion of *B. coli* by polymorphonuclear leucocytes (*p.*); (v) Ingestion of *B. coli* by large mononuclear leucocytes (*l.m.*); (vi) Ingestion of *B. coli* by endothelial cell (*e.*); (vii) Ingestion of polymorphonuclear leucocyte by endothelial cell (*e.*).

Stain.—Pyronin methyl-green (Saathoff).

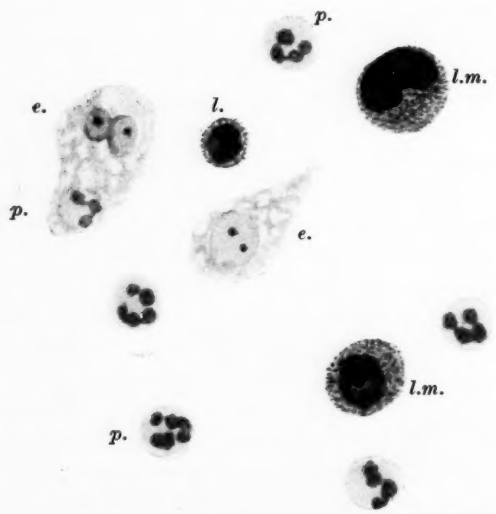

FIG. 7.—*Case XXIII.* APPENDICITIS: LOCALIZED ABSCESS.
Duration of symptoms, 50 hours.

Film of peritoneal fluid, showing: (i) Relative proportion of different cells; (ii) Absence of bacteria; (iii) Healthy polymorphonuclear leucocytes (*p.*); (iv) Two large mononuclear leucocytes (*l.m.*), one lymphocyte (*l.*); (v) Two endothelial cells (*e.*) with vacuolation of protoplasm, one showing nuclear division and an ingested polymorphonuclear leucocyte.

Stain.—Pyronin methyl-green (Saathoff).

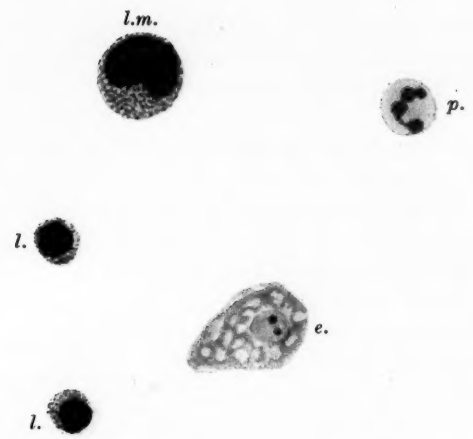

FIG. 8.—*Case XXIII B*, APPENDICITIS: LOCALIZED ABSCESS.

Twenty days after operation.

Film of peritoneal fluid, showing: (i) Relative proportion of different cells; (ii) Healthy polymorphonuclear leucocyte (*p.*); (iii) Large mononuclear leucocyte (*l.m.*); (iv) Lymphocytes (*l.*); (v) Endothelial cell with vacuolation of protoplasm (*e.*); (vi) Absence of bacteria.

Stain.—Pyronin methyl-green (Saathoff).

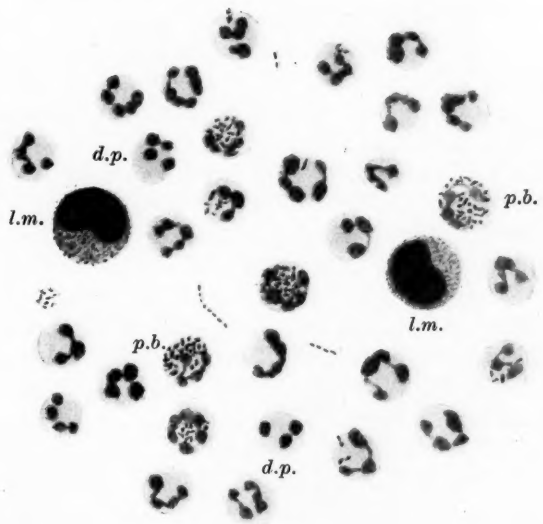

FIG. 9.—*Case XXIV*. APPENDICITIS: GENERAL PERITONITIS.

Duration of symptoms, 18 hours.

Film of peritoneal fluid, showing: (i) Relative proportion of different cells; (ii) Degeneration of polymorphonuclear leucocyte (*d.p.*); (iii) Polymorphonuclear leucocytes full of bacteria (*p.b.*); (iv) Two large mononuclear leucocytes (*l.m.*); (v) Free bacteria.

Stain.—Pyronin methyl-green (Saathoff).

cultural results (which are not available in the case of an immediate examination) has been indicated.

> Wilkie,[4] in advocating an immediate examination in all cases of free, spreading peritonitis, holds that the information obtained indicates whether the peritoneal cavity requires drainage, or whether 'primary closure' may be employed.

In 12 out of the 18 cases of appendicitis in this series an immediate examination was made.

A.—In one case (*Case XIX*) in which the distal half of the appendix was completely gangrenous except the peritoneal coat, immediate examination of the turbid peritoneal fluid showed that it was protective in character, although there were a few bacteria present, both free and ingested by the cells. This proved that the severe clinical features of this case (pulse 126, temperature 100°) were due, not to the condition of the general peritoneal cavity, but to absorption from the appendix itself, and accordingly the question of peritoneal drainage did not arise. The absence of general abdominal pain, tenderness, and rigidity, of course suggested that this was the case.

B.—In six cases of localized abscess, immediate examination of the peritoneal exudate, while demonstrating the protective character of that fluid, did not enable one to dispense with local drainage, as in each case the necrotic abscess wall demanded it. The protective character of the fluid was, of course, suggested by the clinical signs.

C.—In the cases of leaking abscess (*Cases X, XII*) immediate examination of the peritoneal exudate showed that its removal was not called for, as the reactive forces were sufficiently well developed; accordingly the wound was almost completely stitched, a gauze drain being introduced for local drainage. In these cases there was great pain, tenderness, and rigidity over the area where the leakage had taken place.

D.—In only one case of free spreading peritonitis (*Case XX*) was an immediate examination of the exudate made. The character of the almost purulent fluid, which was present in large quantity, was considered satisfactory, and no attempt was made to remove it; a gauze drain was introduced for local drainage, the remainder of the wound being stitched. In this case there was board-like rigidity over the whole abdomen.

Thus the value of an immediate examination is greatly limited by the fact that in almost every case in which it would indicate the need for, or inadvisability of, peritoneal drainage, local drainage is called for.

Again, there is no doubt that *effective* drainage of the general peritoneal cavity is impossible. The usefulness of the 'local gauze drain' depends on the formation of adhesions which isolate the local area of necrosis from the general peritoneal cavity, the deeply situated abscess wall being thus transformed into what is virtually a superficial ulcer. The gauze acts as a drain for only a few hours.

Further, in almost every case which comes to the surgeon, the removal of the exudate, if not actually injudicious, is quite unnecessary. This was well shown in two of my cases in which no immediate examination was made. In *Case XXIV*, although no attempt was made to remove any of the enormous

quantity of thick pus which was absolutely general in the peritoneal cavity, large quantities of which poured out of the wound during the operation, and although very little came through the local gauze drain, yet the patient's recovery was rapid. Thus no peritoneal drainage was necessary for this fluid, which contained many free bacteria, and in the cells of which degenerative changes were extensive (***Fig.*** 9).

In *Case XXII* the fluid, although merely turbid, was even less favourable, but the results of the peritoneal reaction, as shown by the improvement in the fluid sixty hours after the operation, showed that no peritoneal drainage had been required (***Figs.*** 5, 6).

On the other hand, if the reactive forces of the peritoneum have been overcome by the infective forces, as in *Case V* (*see* page 25), it is certainly wise to remove the fluid so far as possible. In this case a rubber drainage tube introduced into the pelvis through a suprapubic incision (in combination with Fowler's position) may be effective, as the amount of fluid in the peritoneal cavity is, in these cases, very large; but even this does not *effectively* drain that cavity, and the improvement, if any, will probably be merely temporary.

A minor, but not unimportant, objection to the employment of an immediate examination is that, unless the microscopist is both skilled and speedy, the surgeon's work is completed before the stained film is ready for inspection, as the operation ought in no case of acute appendicitis to exceed fifteen minutes.

CONCLUSIONS.

1. The 'mononuclear phagocytes' in the peritoneal exudate consist of two different types of cells, endothelial cells and large mononuclear leucocytes, which not only have two distinct sources of origin, but also can easily be distinguished from each other in all stages of their functional activity by the ' indophenol-synthesis' test for oxydase.

2. Examination of the peritoneal exudate is of great prognostic value in cases of spreading peritonitis, as it indicates the amount and virulence of the bacterial invasion and the extent to which the reactive forces of the peritoneal cavity have been, or are being, developed. In considering the significance of the relative number of the various cells, their phagocytic activity, and their healthy or degenerated character, the duration of the bacterial invasion must always be borne in mind.

3. The contention that an immediate examination of the exudate in cases of spreading peritonitis supplies information which indicates whether drainage of the peritoneal cavity is necessary or whether primary closure may be employed, must be modified by three facts, viz.: (*a*) Local drainage is very often necessary although drainage of the general peritoneal cavity may be not only unnecessary but also injudicious; (*b*) Drainage of the general peritoneal cavity is only called for in *very* exceptional cases; (*c*) *Effective* drainage of the general peritoneal cavity is impossible.

Of the 24 cases investigated, 19 were operated on by me in the Victoria Infirmary, Glasgow, in the wards of Mr. Maylard, Mr. Parry, and Mr. Grant Andrew, to whom I am indebted for permission to publish the results.

To Dr. John Anderson, the Director of the Pathological Laboratory at the Victoria Infirmary (where the laboratory work was done), I am deeply in debt for many suggestions.

My thanks are also due to Dr. Whitelaw for assistance in the histological work, to Dr. J. Shaw Dunn for valuable suggestions regarding the usefulness of the oxydase reaction, and to the various House Surgeons who undertook the immediate examinations.

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RESULTS OF OPERATION FOR MALIGNANT TUMOURS OF THE BREAST.

By GEORGE E. ARMSTRONG, Montreal.

More general diffusion of knowledge regarding malignant disease is a public need. The comparatively good results that are now obtained in the best hospitals are not appreciated by the public generally. One may go further, and say that the advances in treatment and the improved statistics now available are not appreciated by a considerable proportion of the general practitioners; and further yet, that they are not always recognized by some of the active members of the hospital medical boards. No better missionary work can be undertaken than the education of the lay public on this great question. Hospital surgeons are tremendously handicapped, not by the indifference of the public to this question of malignant disease, because they are not indifferent; but by their lack of knowledge and appreciation of its many sides. The fundamental facts that cancer is at the start a local disease, and that the only successful way of treating it is to remove it, should be shouted from the housetops.

Up to the present, early recognition and early removal offer the best means of getting rid of a disease that, unrelieved, progresses steadily, and sooner or later destroys life.

Until we know more of the causes of cancer, and discover some better method of treatment than now obtains, our results will improve only as the public realizes more clearly the importance of early removal of all malignant neoplasms and of all lesions known to favour the development of cancer.

In December, 1907, I published in the *Montreal Medical Journal* a report of 90 mammary tumours, with special reference to the end-results in the patients from whom malignant growths had been removed. Of the 90 tumours, 26 were benign, 63 were carcinomatous, and 1 a sarcoma. Of the carcinomatous tumours, 46 had been removed more than three years; 13 were alive and well, or 28·5 per cent; 18 could not be traced. In the above percentage estimate of recovery, the eighteen untraced cases were considered to have died from a recurrence of the disease.

I now present another series of 102 cases of mammary tumour: carcinoma, 87 cases; sarcoma, 2 cases; fibro-adenoma, 13 cases. One of the cases of sarcoma disappeared, at least I can find no trace of her; the other died of recurrent disease two years after operation.

Of the carcinoma cases, 5 were not submitted to operation, 3 being clearly inoperable, and 2 refused operation. In the remaining 82 cases the complete operation was performed. I have been able to trace 65 of these, and find 33 of them alive and well three years after operation, or 50 per cent. If we consider the remaining 49 to have died of recurrence, we have 33 out of

82 cases alive and well three years after operation, or rather more than 40 per cent. The above figures include all my cases, both public and private.

In tracing some of the cases reported in 1907, I find that 1 is alive and well seventeen years after operation, 1 fifteen years, 1 fourteen years, 3 ten years, 2 nine years; and in the present series, 3 seven years, 6 six years, and 5 five years. If the present series shows better results than the first, it is chiefly because the disease has been recognized earlier.

If we add the two series together, we have 150 cases of carcinoma of the breast operated upon. Counting all cases not traced as having died of recurrent carcinoma, we find 46 alive and well three or more years after operation, or 30 per cent. These figures, although somewhat encouraging, are far from satisfactory. When we know that the disease is at first an entirely local condition, and that modern surgical technique renders possible the total removal of the disease with only what may be termed an accidental mortality, we cannot but feel that if patients applied earlier, the percentage of cases remaining free from recurrence should be 70 instead of 30.

The complete operation was performed in every case; that is to say, the whole breast was removed, together with the sternal portion of the pectoralis major muscle, the pectoralis minor, the glands in the axilla, the fascia covering the serratus magnus, the anterior border of the latissimus dorsi, and the upper part of the external abdominal oblique. The triangle of the neck was dissected in those cases in which it seemed to be indicated. During the past twelve years or more, I have begun the operation by dividing the outer attachments of the pectoral muscles to the humerus and to the coracoid process, as first recommended and practised, I believe, by Arpad G. Gerster, of New York.

There can be little doubt that, as pointed out by Handley, our knowledge of the cancerous processes in the breast, and the comparatively better results now obtained by improved scientific technique in operation, are in large measure due to English-speaking surgeons. We are greatly indebted to Moore, Banks, Handley, and Stiles in Great Britain, and to Gross, Gerster, Halsted, Rodman, and Meyer in America.

The complete operation is a safe one. In the 150 complete operations for carcinoma of the breast there was only one death, and this should not have occurred; it was the result of faulty preparation of the patient for operation. There was a fungating mass. The line of incision was not properly protected, and infection occurred which proved fatal. The most satisfactory preparation of such cases in my experience is thorough, deep cauterization. In the above unfortunate instance the dirty wound was treated by the application of pure carbolic acid. In similar cases prepared by cauterization I have had no trouble whatever.

There is no disability following the removal of the sternal portion of the pectoralis major and the pectoralis minor. There was a case reported in New York, in which a woman from whom the pectorals had been removed on each side, was earning her living as a charwoman. After the complete operation it is the exception to find any appreciable weakness or lessened range of motion. The complete operation does not prolong the period of disability.

The teaching of Sampson Handley indicates that undue rough handling of a carcinomatous breast is unwise. Cancer cells are perhaps dislodged and forced along lymphatic vessels more easily and more frequently than we have appreciated. In my clinic I always see to it that students palpate mammary tumours with gentleness.

A case operated upon eight days ago presented points of more than usual interest. The right breast and the glands of the right axilla had been removed three years before by another surgeon. On examination, I found a recurrent nodule at the sternal end of the old cicatrix. The glands on the lower border of the left pectoralis major and in the left axilla were enlarged and hard. There was also a hard nodule palpable above the left clavicle. No evidence of disease could be detected in the left breast. Apparently the cancer cells had been forced across the median line along the deep fascia to the left axilla. We found, then, the axillary and supraclavicular glands on the left side involved before the breast on that side. This unusual sequence of events may perhaps have been due, in part at least, to the fact that the lymphatic vessels running to the right from the recurrent nodule had been removed at the first operation three years before. There was no evidence of mediastinal involvement.

It is conservative surgery to remove all fibro-adenomas from the breast. The evidence is about conclusive that in some instances their presence favours the occurrence of conditions that lead to the development of malignant disease.

Until we have more knowledge of cancerous processes, would we not be acting in the best interests of our patients if we inaugurated a campaign against all habits, occupations, and histological deviations from the normal that are known to be followed in a very considerable percentage of cases by malignant disease? Chimney-sweep cancer has been abolished by act of parliament, and so might be Buyo cheek cancer, Kangri skin cancer, the skin cancer on the arms of paraffin workers, and the brand cancer of cattle.

There are 75,000 deaths annually from cancer in the United States. A well-organized crusade against all conditions predisposing to this dread disease would lessen the number of cases very materially. Let us fight it with the best weapons that we have to-day, namely—early diagnosis; early removal of the disease when it occurs; the removal of the so-called pre-cancerous conditions when that can be done safely without causing disability; and the prevention by legislation of habits, customs, and labour conditions that have been shown to be etiological influences.

THREE MESENTERIC TUMOURS.

By ERIC PEARCE GOULD, London.

The three tumours, details of which are given below, are of interest, not only by reason of their position, but also on account of the uncertainty of their pathology. If the most probable diagnosis, viz., tuberculosis, be the correct one, they also serve to illustrate an unusual form of this disease as it occurs in the abdomen, a form, moreover, which admits of satisfactory treatment.

For permission to publish these notes I am indebted for the first two to Sir Alfred Pearce Gould, under whose care the two patients were admitted to the Middlesex Hospital, and for the third to Dr. C. E. Lakin, formerly Curator of the Hospital Museum.

CASE I.

E. S., a single woman, age 29, was admitted June 30, 1912. Her family history was good. Eighteen months previously she had an attack of 'bronchopneumonia.' Nine months before admission she had suffered with an attack of pain in the right iliac fossa lasting several hours. Fourteen days before admission she had a second attack, and she still complained of pain in the same region, and also in the mid-line just below the umbilicus.

The patient was a well-nourished, healthy-looking girl. Temperature 98·4° C., pulse 88. On examining the abdomen, there was very definite tenderness over the appendix. Just below the umbilicus a tumour could be felt. This tumour had an irregular outline, in size about that of a Tangerine orange. It was dull on percussion, slightly movable from side to side, but all manipulation was painful. A diagnosis of appendicitis was made, the nature of the tumour being doubtful.

Operation.—*July* 2, 1912. The abdomen was opened by a vertical incision in the lower half of the right semilunar line. The appendix, which was chronically inflamed, was removed. On investigating the tumour, it was found to be situated in the mesentery of the ileum, half-way between its root and attached border. It was yellow in colour, with enlarged mesenteric veins coursing over it. It was lobulated in outline, and varied in consistency, the central part being clearly fluid, whilst round the edge it was firmer and semi-solid. An attempt was made to enucleate the whole tumour from between the layers of the mesentery. But after some time had been spent in careful dissection, during which the tumour wall was broken through and part of its contents escaped, it became clear that to persist in the attempt at complete removal would not only be a prolonged and tedious operation, but would also imperil the vitality of that part of the gut the veins of which were crossing the tumour. It was decided, therefore, to remove as much as possible. The anterior wall of the cyst was cut away, and the contents, both fluid and semi-solid, were carefully wiped out. The bleeding was dealt with, and the abdomen then closed in layers without drainage.

The patient made an uninterrupted convalescence, and left the hospital three weeks later. At that time there was nothing abnormal to be felt in the abdomen, but she was advised to go into the country for rest and open-air treatment for a period of three months. At the end of this time she returned to her work as a children's nurse, in apparently perfect health.

Pathological Report.—That part of the wall of the tumour removed showed that the cyst consisted of a number of loculi surrounding a central cavity. On

section, the wall was composed of dense fibrous tissue, with slight round-celled infiltration in places. No epithelial elements could be detected.

The contents were partly fluid and partly semi-solid: the fluid portion, of pus-like character, was composed of a granular and fatty débris; no pus-cells were present, and no organisms were isolated. The semi-solid part, of putty-like consistency, was composed of caseous material, with here and there gritty calcareous particles.

CASE II.

A. S., a married woman, age 39, was admitted to the Middlesex Hospital on October 4, 1912. She was a healthy-looking woman of spare habit, and complained that for the last three or four years her lower abdomen had been gradually getting larger. Apart from this, she had absolutely no symptoms. Her family history was good, and her previous history disclosed nothing but an injury to her right fibula (? fracture) at the age of 11.

Her heart and lungs were normal, and her urine contained no abnormal constituent. On examining the abdomen, it was at once apparent that there was a tumour projecting just above the pubes in the middle line. It felt about the size of a large orange, was smooth on the surface, spherical in shape, fluctuated, and was not tender. There was impaired resonance over it, but normal resonance above and on each side; and it was freely movable, especially upwards. The tumour could be felt per vaginam, but its freedom from the uterus and appendages was quite clear.

Operation.—*October* 8, 1912. The abdomen was opened by a median sub-umbilical incision, four inches in length, the patient being placed in the Trendelenburg position. The tumour was found to be situated between the layers of the mesentery of the ileum, about four feet from the ileocæcal junction, and so placed as to leave two inches of unaltered mesentery between the tumour and the gut. There were no adhesions to surrounding coils, and no enlarged mesenteric glands could be felt. The tumour was delivered out of the abdomen, and the superficial layer of the mesentery incised. By blunt dissection the mesentery was stripped off, and the tumour enucleated whole (*Fig.* 10). The cut edges of the mesentery were united by two or three interrupted thread sutures, and the abdomen closed with three layers of sutures.

The patient made a normal convalescence, and left the hospital on October 29. On December 20, 1912, the patient reported herself as quite well.

Pathological Report.—The tumour, the size of a small cocoanut, was cut across and found to consist of two cavities completely divided by a transverse septum (*Fig.* 11). Both cavities were filled with the same material, a thick creamy fluid of greenish-yellow colour. On emptying the cysts, the lining, in most places smooth, was here and there covered with plaques of sticky material of the same colour. Microscopically, a section taken at the junction of the septum with the cyst walls showed that the wall of each cyst, as well as the septum, was composed of tough fibrous tissue with no epithelial lining, with in places collections of large plasma and small round cells.

The fluid contents were composed of fatty and granular particles. No organisms were isolated from the fluid.

CASE III.

The third tumour was obtained post mortem from E. S., a man, age 73, who was admitted to the Middlesex Hospital on May 1, 1895, and died of chronic interstitial nephritis two days later. The tumour was noticed during the patient's lifetime in hospital, and in reply to questions, he stated that he had known of it for sixteen years. It had given him no inconvenience, and had been variously diagnosed by surgeons in different parts of the world—the patient was a sailor—as a floating spleen or floating kidney. Its great mobility is shown by the patient's statement that sometimes it lay on the right side, and sometimes on the left, of his abdomen.

The tumour was smooth on the surface, rounded in outline, elastic, and freely movable. The percussion note was dull over the tumour, with resonance all round.

At the time the patient was examined, it was situated to the right of, and below, the umbilicus. On firm pressure the wall of the tumour was felt to yield with a crackling sensation.

The post-mortem records state that "six feet from the ileocæcal junction there was a cystic tumour the size of an ostrich egg, between the layers of the mesentery, with a coil of ileum spread out over its convexity. The wall of the tumour was an eighth of an inch thick, smooth on its outer surface, but roughened internally owing to the presence of flat calcareous plates in places. The contents of the cyst were 4 oz. of creamy material. No hairs were to be found in this."

A microscopical section of the wall of the cyst, made recently for the purpose of this report, showed a structure exactly comparable to that found in *Cases I* and *II*, i.e., dense fibrous tissue with no epithelial lining.

It is clear that no one of these tumours belongs to a recognized pathological variety of mesenteric tumour, although the third one had been catalogued for many years as a mesenteric dermoid. Apart from the fact that all mesenteric dermoids hitherto reported have occurred in the female sex, no trace was found in this tumour of any typical epithelial product such as hair, teeth, or perles. A similar absence in the other two cases excludes the diagnosis of dermoid in them also. It is true that suppuration in a dermoid, hydatid, or other cystic tumour may render its diagnosis with certainty difficult; but in these cases there was nothing in the specimens themselves, or in the histories, to suggest suppuration, such inflammation as was present in the first case being merely a superficial extension from the adjacent appendicitis.

How, then, is one to explain the origin in this situation of tumours which are single, circumscribed, and symptomless (apart from their mere bulk), and which consist of a fibrous wall enclosing semi-solid or fluid contents which, under the microscope, consist of a fatty, granular, and in part calcareous, débris? Such a description is at once suggestive of a 'cold abscess'; and raises the question, are they tuberculous in origin? But neither tubercle bacilli nor giant-cell systems were to be found in any of them. The presence of either of them would, of course, settle the question. Does their absence negative this explanation? Not of necessity, for lesions of undoubted tuberculous origin do occur in other parts of the body in which the typical appearance of cells or the causative organisms are extremely difficult to find. The evidence in favour of these tumours being tuberculous is supported by their close resemblance to the following three cases in which the diagnosis was made with certainty.

The first was recorded by Beatson in 1898, under the title of "Case of Excision of Large Tuberculous Abscess." The patient was a boy, age 4, who a week before coming under notice was observed by his mother to have a "lump in his belly." His chest and urine were normal. In his abdomen a lump the size of a cocoanut was felt. It was situated just below the umbilicus, was smooth on the surface, and movable from side to side. At the operation, it was found to be situated in the mesentery. With difficulty it was removed entire, a few enlarged mesenteric glands being also found. The patient made a good recovery. Pathologically, it was a "typical tuberculous abscess."

The second case was that of Kukula, published in 1899. His patient was a woman, age 39, who complained of intermittent pain in her back

FIG. 10.—*Case II.* MESENTERIC TUMOUR AFTER ENUCLEATION.

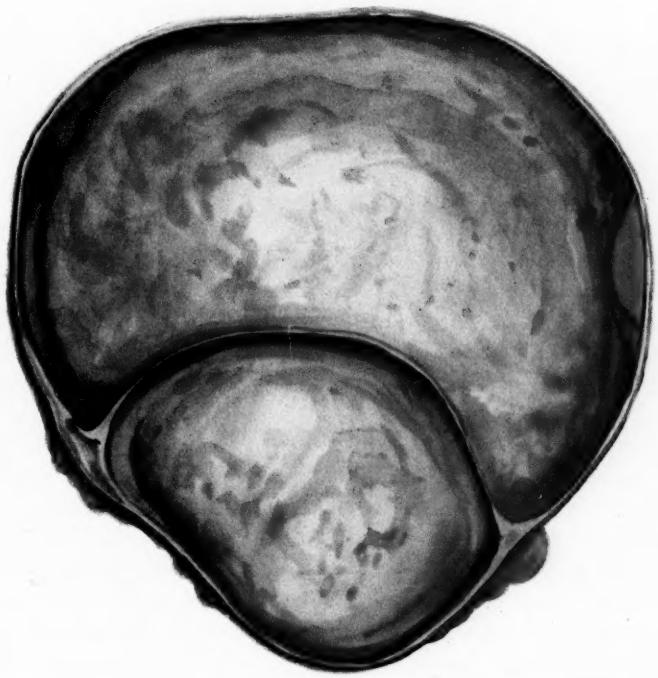

FIG. 11.—*Case II.* SECTION THROUGH THE TUMOUR.

and abdomen of three months' duration, and increasing severity. A tumour the size of a goose's egg was found in the abdomen below and to the left of the umbilicus, crossed by a transverse groove. Its surface was smooth, it appeared solid, and was very freely movable in all directions. Inflation of the colon demonstrated that the tumour lay below the transverse colon, and to the inner side of the descending colon. It was not connected with the pelvic viscera. A diagnosis of solid mesenteric tumour was made, and exploration decided upon. The tumour was found to be situated in the root of the mesentery. A few small glands were felt in other parts of the mesentery. An attempt at enucleation failed, and the tumour was therefore removed entire, with the involved mesentery and attached intestine. In this operation over seven feet of ileum was resected. The tumour measured 3 by 2 inches, was soft in the centre, firm all round. Microscopically, tubercle bacilli and giant cells were found, and fluid granular detritus. The patient died two and a half years later, and the autopsy revealed caseating mesenteric glands, one of which had burst into the peritoneum and set up a fatal tuberculous peritonitis.

The third case, published by Baum in 1902, was a man, age 27, who had complained of abdominal pain for seven weeks. He was found to have a tumour, the size of the palm of the hand, situated just under the umbilicus. It was dull on percussion, did not yield a sense of fluctuation, and was movable from side to side. At the operation it was found to be a nobbly mass, the size of a fist, in the root of the mesentery. It was excised complete, together with a length of ileum. Pathological examination showed it to be a multilocular abscess containing thick creamy material. Tubercle bacilli and giant cells were found in the wall, and a crop of miliary tubercles in the adjacent mesentery. Three and a half months later the patient was in perfect health and still gaining weight.

In all these cases it is safe to assume that the mesenteric lymphatic glands were the structures involved. But tuberculosis of these glands is common, whilst these tumours are rare. Is it possible to harmonize their occurrence with the clinical manifestations of tuberculosis in general and with the more normal manifestations in the abdomen? It is not uncommon to find, when operating in the abdomen for some other condition, one or more enlarged glands in the mesentery. The enlargement is usually ascribed to tubercle, and such glands, as a rule, either with or without treatment, remain free from any harmful effect on the patient. Such cases are strictly comparable to the isolated, frequently healed, tuberculous lesions found post mortem in the apices of the lungs. In other words, the resistance of the individuals is able to limit and rapidly overcome an invasion by the tubercle bacillus in one or other situation. Still better known, however, are the cases in which the natural resistance breaks down before the infection, with the result that the disease advances and spreads, giving us, in the case of the mesentery, the clinical picture of 'tabes mesenterica,' with its masses of breaking-down glands infecting the peritoneum on all sides and producing the constitutional effects of advancing tuberculosis; or, in the case of the lungs, a progressive caseating bronchopneumonic type of phthisis.

But it is easy to imagine an intermediate condition in which the forces are more evenly balanced, and in which, after a preliminary advance on the part of the tubercle bacilli, the body improves its powers of resistance, and checks all further advance without being able to repair the damage already done. That this occurs in pulmonary infection is shown by the cases in which one or more old-standing tuberculous cavities are found in the lungs, which have not been further affected. It is surely not stretching the imagination to see in these cases of isolated tuberculous abscesses in mesenteric lymphatic glands a similar pathology, and to regard them as cases of *arrested* mesenteric tuberculosis. We are familiar with cured tuberculosis in this region, and also with progressive; but it is this arrested form which is perhaps overlooked, in spite of the fact that when it occurs it demands surgical treatment.

The notes of the five cases operated on show that in four of them the tumour was removed entire. That this is the ideal operation there can be no doubt, although the after-history of one of them demonstrates the possibility of some other focus causing active disease subsequently. The surgeon encounters two difficulties in dealing with mesenteric tumours: the tumour may be so near to the bowel that its removal without sacrificing a length of bowel is impracticable; or so near the root of the mesentery that the large vessels, particularly the mesenteric veins, are endangered.

The successful removal of the entire tumour should mean the conversion of an arrested tuberculosis into a cured one, and the attainment of such an end well repays the surgeon for the patience and careful dissection which are needed.

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A CASE OF RETROPERITONEAL HERNIA CURED BY OPERATION, WITH A REPORT ON THE LITERATURE OF THE SUBJECT.

By A. RENDLE SHORT, Bristol.

Eight years have elapsed since Moynihan and Dobson published their comprehensive treatise on the subject of retroperitoneal hernia, summing up all that had been contributed by others up to the year 1906, and welding it into a composite picture. The writer has taken advantage of a case of this uncommon disease occurring in his own practice to report upon the international literature from that date to the present time.

Case.—**Woman, age 40, with acute intestinal obstruction. Operation. Loop of small intestine incarcerated beneath cæcum, entering from the outer side. Coils withdrawn and drained. Cure.**

A. A., a married woman, age 40, was sent into the Bristol Royal Infirmary, August 28, 1914, with symptoms of acute intestinal obstruction lasting five days.

There was nothing of note in the previous history, except that three weeks ago she had had what was described by her doctor as a bad attack of enteritis, with vomiting, abdominal pain, and diarrhœa.

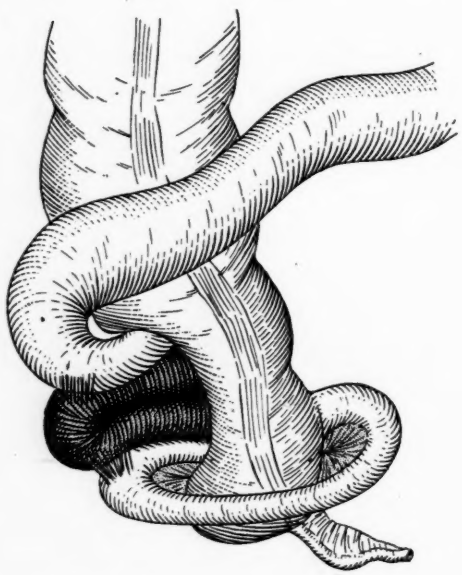

Fig. 12.—Retroperitoneal Hernia. (*Author's case.*)

The symptoms of the present attack dated from five days ago. Since then the bowels had not been opened, in spite of enemata; there had been colicky abdominal pain, and vomiting which, during the past two days, was almost fæculent in character.

On admission, the patient looked very ill, pulse 132, temperature 97°. The abdomen was distended, tense, and rather rigid. A diagnosis of intestinal obstruction was made, and immediate operation performed.

Under open ether anæsthesia an incision was made in the middle line below the umbilicus. About a pint of free fluid escaped when the peritoneum was opened, and coils of small intestine were seen to be dilated and congested. The examining hand detected fixation of the small bowel in the right iliac fossa. On enlarging the incision and retracting the abdominal wall, a pouch was demonstrated behind the cæcum, with the opening looking outwards, approximately opposite the ileocæcal junction (see *Fig* 12). This contained about 2 feet of ileum. Above, there entered the distended afferent loop; below was the collapsed efferent bowel, which immediately crossed the cæcum and ran directly to the ileocæcal valve. Between these was a projecting

omega-loop of black gut, which appeared to be gangrenous. One had, therefore, to deal with a hernia-en-W. The coils of gut were bound together by massive, but soft and fairly recent, adhesions. The thickened anterior lip of the fossa had to be divided, and great care taken to avoid nicking the cæcum, before the incarcerated bowel could be withdrawn. As may be supposed, it was by no means easy either to discover exactly what had occurred, or to free the soft and friable coils of gut from one another and from the walls of the fossa. After liberation, the black intestine improved in appearance, and it was judged to be recoverable. The bowel was therefore incised, a long glass tube inserted, and many feet of gut drawn up over the tube so as to empty the foul contents. Then the incision in the bowel was closed, and the abdominal wound sewn up. The patient's condition did not permit of any attempt to obliterate the fossa.

After operation, the patient was kept sitting up in bed, saline and glucose solution was administered per rectum, and physostigmine salicylate given hypodermically. She made an uneventful recovery.

Discussion of the Case.—So far as I can discover, the fossa into which the bowel had entered in this patient is not one previously described. Four pouches are known in the pericæcal region in which herniated loops have been entangled—the retrocolic fossa, ileo-appendicular fossa, the fossa of Hartmann, and the fossa iliacosubfascialis of Biesiadecki. The anatomy of these will be described later.

In the present case there was a cavity about as large as the closed fist behind the cæcum and ascending colon, approximately opposite the ileocæcal valve, but somewhat above its level; there was a well-marked ring around the orifice, and the opening looked principally outwards, but slightly forwards. No important vessels were in relation to the sac. There was no evidence of old peritonitis. No rounded swelling was made out in the patient's abdomen before operation, such as has been described in other cases of retroperitoneal hernia.

The only other cases in the literature of pericæcal hernia cured by operation are those described by Marsh, Riese, Macewan, Aschoff, and Neumann.

THE RECORDED CASES OF INTERNAL HERNIA, 1906–14.

An attempt has been made to obtain a complete list of the recorded cases during this nine-year period, using the *Index Medicus* and a number of other references not contained even in that monument of industry. Unfortunately, a relatively large proportion of reports occur in Polish, Spanish, Portuguese, Swedish, Roumanian, and out-of-the-way German journals and monographs, which do not appear to be available in this country. A list of these references is subjoined separately.

The classification of Moynihan and Dobson is followed.

Left Duodenojejunal Fossa.—This fossa, the fossa of Landzert, is the commonest site of internal hernia; it lies close to the junction of the duodenum and jejunum, is open to the right, and in its anterior border is found the inferior mesenteric vein. Up to 1906, Moynihan and Dobson record 65 cases of left duodenal hernia, with 8 recoveries after operation for strangulation.

In our table, records will be found of 11 cases in which a hernia in this situation gave sufficient trouble to warrant operation. In 9 cases there was

Date	Reporter	Sex	Age	Description	Treatment	Result
	Hernia of Left Duodenojejunal Fossa.					
1906	Sherren ..	F	13	Symptoms of acute strangulation. Rounded swelling size of cocoanut	Operation and reduction	Cured
1906	Barker ..	M	56	Met with unexpectedly in course of performing gastrojejunostomy for cancer of stomach	Operation abandoned	—
1906	Merke ..	F	46	Found at autopsy. No symptoms	—	—
1907	Schoppler ..	F	30	Found at autopsy. No symptoms	—	—
1907	Vautrin ..	M	32	Symptoms of acute obstruction one week	Operation; reduction; sac closed	Cured
	,, ..	M	31	Chronic obstruction 1 year, ending acutely. Mass felt like a growth	Operation; reduction; sac closed	Cured
1908	Crisler ..	—	—	No details available. Symptoms of strangulation	—	—
1909	Heller ..	F	Adult	Chronic obstruction 6 months, ending acutely	Operation	Cured
1909	Felten ..	F	15	Diagnosed as ovarian cyst ..	Operation	Cured
1911	Von Holst ..	—	—	Symptoms of strangulation. No details available	—	—
1911	Obrastzow*	F	17	Strangulated	Operation	Died
1912	Pikin* ..	F	27	Periodic attacks of pain and vomiting. Diagnosed as obstruction or ovarian cyst	Operation	Cured
1912	Gobeit ..	M	28	Strangulated	Operation	Cured
1912	Priebatsch	F	2	Strangulated, became gangrenous	No operation	Died(peritonitis)
1913	Thomas ..	M	32	No symptoms. Found P.M. ..	—	—
	,,	M	2	No symptoms. Found P.M. ..	—	
1913	Bassedas* ..	—	—	Found P.M.	—	—
	Hernia of Right Duodenojejunal Fossa.					
1907	Haasler ..	—	—	Strangulation	Operation	Died
	Pericæcal Hernia.					
1910	Matthews ..	M	69	Acute obstruction. Subcæcal hernia found at autopsy	No operation	Died
1911	Krynski ..	—	—	No details available	—	—
1912	Marsh ..	M	34	Subcæcal. Signs of strangulation	Operation	Cured
1912	Ransohoff ..	—	—	Retrocæcal. No details available	—	—
1914	Short ..	F	40	Acute obstruction 5 days. Sac behind cæcum, opening outwards	Operation	Cured
	Hernia into Foramen of Winslow.					
1908	Carwardine	M	44	Acute obstruction	Operation; bowel could not be reduced	Died
1909	Haw ..	M	5	Acute obstruction. Moribund. Bowel could not be reduced at autopsy	No operation	Died

* In these cases it is not certain that the hernia was into the *left* duodenal fossa.

Date	Reporter	Sex	Age	Description	Treatment	Result
				Hernia of Intersigmoid Fossa.		
1909	Coley ..	M	3 days	Acute obstruction. Hernia found at autopsy	No operation	Died
				Hernia of Cave of Retzius.		
1908	Fromme ..	M	59	Strangulation. Bowel in sac behind symphysis pubis, to the left, in front of bladder	Operation	Cured
				Hernia through the Transverse Mesocolon.		
1909	Mayo ..	F	59	Pain, vomiting and wasting for years. Duodenal ulcer found at operation	Gastrojejunostomy	Cured
	„ ..	F	32	The same	Gastrojejunostomy	
1910	Stolzenberg	M	37	Found at autopsy after attacks of pain for years	—	—
1912	Halpenny ..	F	28	Recurrent attacks of pain ..	Operation	Cured

acute strangulation; in 2 the diagnosis of ovarian cyst was suggested. In 3 of the obstructed cases there had been prolonged trouble for six months or more. In several patients a lump was felt, which, as Vautrin remarks, may be resonant, soft, tender, and variable from hour to hour. Of the 8 cases operated on with a known result, all but one were cured, which is a very favourable result in comparison with cases of intestinal obstruction generally. Probably some fatal cases have passed unrecorded.

There are given 6 other examples in which the condition produced no symptoms, but was discovered at autopsy or operation. In a patient under Barker's care it made the operation of gastrojejunostomy for cancer of the pylorus impossible.

Right Duodenojejunal Fossa.—This fossa, also known as the fossa of Waldeyer or Brösike, lies close to the junction of the duodenum and jejunum; it is open to the left, and the superior mesenteric artery lies in its exterior fold. Up to 1906 Moynihan and Dobson collected 17 cases, one of which (Neumann's) was cured by operation.

I have found one case recorded since, by Haasler. This patient was operated on, but died.

Pericæcal Fossæ.—*The retrocolic fossa* lies behind the cæcum and ascending colon. The opening looks downwards. Occasionally the fossa is double.

Moynihan and Dobson accept 7 cases as authentic, 2 of which recovered after operation for strangulation. To this I have added 3, described by Matthews, Marsh, and Ransohoff. Marsh's patient recovered after operation.

There are also a number of cases described of attacks of appendicitis where the appendix has lain in a retrocolic fossa. Gümbel gives an account of finding the appendix in such a position accidentally, post mortem. Most surgeons, however, must have met with examples of this condition in the

course of operation for appendicitis; quite a number have occurred in the writer's practice.

The ileo-appendicular fossa lies between the abnormal ileo-appendicular fold (bloodless fold of some authors) and the mesentery of the appendix; the termination of the ileum lies above it. The opening looks to the left and downwards.

Moynihan and Dobson mention 7 cases in the literature, which they accept as examples of hernia into this fossa. Of these, 2 (Riese, MacEwan) recovered after operation for strangulation.

I have not found any subsequent records of this condition, but there are several examples in the literature of sequestration of the vermiform appendix in this fossa, with or without acute appendicitis supervening. Allen has collected a series of 5—two mentioned in Lockwood's book on appendicitis, one each by Elliott and Wood, and Allen himself contributes a fifth, discovered during an operation for acute appendicitis in a man, age 36. Recently Seff has described another similar case.

The fossa ileocæcalis infima, of Hartmann, lies between the meso-appendix and an attachment of the mesentery to the iliac fossa running from the ileocolic angle to the posterior and inner aspect of the cæcum. The fossa looks downwards.

One doubtful case (Snow's) of hernia into this fossa is known.

The fossa iliacosubfascialis, or fossa of Biesiadecki, lies in the middle of the right iliac fossa, looking upwards. The anterior wall is formed by a fold of the iliac fascia.

Mott has described a hernia of the appendix into this fossa, and there is a doubtful case (Engel's) in which it contained bowel.

The aperture in which ileum was snared in the patient whose history is presented in this article, was neither of these four recognized peri-cæcal fossæ. As will be seen in the diagram (*Fig.* 12), the cavity lay behind the cæcum and ascending colon, but the opening was to the outer side, looking to the right and slightly forwards. The cavity would contain the closed fist, but the orifice would only admit three or four fingers.

Foramen of Winslow.—Moynihan and Dobson found 12 examples of this hernia in the literature, to which I have added 2 more, described respectively by Carwardine and Haw. The first of these occurred at the Bristol Royal Infirmary, at which also my case was treated. Out of 6 patients operated upon, only 2 recovered (Neve, Delkeskamp).

Intersigmoid Fossa.—There is 1 case (Coley's) to be added to the 2 previously described by Eve and Macadam Eccles. Coley's patient was a new-born male infant which died of acute obstruction coming on when the child was three days old. The sac was very large; it lay to the outer side of the sigmoid flexure, the opening looking downwards and to the right. No operation was considered possible.

Fromme's Fossa.—A unique case is described by Fromme, in which he operated successfully for acute intestinal obstruction, and found the bowel lodged in an abnormal fossa behind the symphysis pubis, somewhat to the left of the middle line, and in front of the bladder. The patient was a man, age 59.

Hernia through the Transverse Mesocolon.—This is not the same as Moynihan and Dobson describe, on the basis of Astley Cooper's case, as *mesocolic hernia.* It occasionally happens that ileum obtains access to the lesser peritoneal sac through a slit or tear in the transverse mesocolon. Moynihan and Dobson found 4 examples of this in the literature (Schwalbe, Boettcher, Chalmers, Ackermann). None of these gave rise to symptoms of obstruction.

Since 1906, further examples have been recorded by Halpenny, Stolzenberg, and Mayo. Halpenny operated for recurrent attacks of abdominal pain; his patient was a woman, age 28. She was quite cured. Stolzenberg discovered the condition at autopsy in a man, age 37; but there had been attacks of pain for years. He quotes from the literature the cases mentioned by Moynihan and Dobson, and also 5 others, reported by Deville, Ihsecke, and three Swedish surgeons.

W. J. Mayo has met with the condition twice, in patients who were also suffering from duodenal ulcer, and had long complained of attacks of pain and vomiting, with dilated dropped stomachs. He considers that the hernia was due to the frequent violent vomiting. His patients were cured by gastro-jejunostomy.

We have, therefore, 13 examples of this variety of internal hernia in the literature.

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A CLINICAL STUDY OF ACTINOMYCOSIS, WITH ILLUSTRATIVE CASES.

By V. ZACHARY COPE, London.

Definition.—By actinomycosis we designate a condition of chronic inflammation consequent on infection with a form of streptothrix which at some time or other in its evolution in the tissues leads to the formation of characteristic small granules composed of the fungus. Whilst recognizing that there may be many kinds of streptothrix which are pathogenic to human beings, we believe it a wise proceeding to retain the above term in addition to the more general term streptothrichosis, for there is accumulating evidence to show that the great majority of cases in man are due to one specific variety of infecting organism.*

Frequency.—Actinomycosis is known to be a common disease in cattle, but is usually regarded as affecting man infrequently. Judging by the general expression of opinion in this country, one would conclude that it was at least something of a rarity. Statistics collected in 1912 showed that during the ten previous years a total of 136 cases were admitted to the wards of seven of the largest hospitals in London; this number is very small, and would at first sight appear to support the view that the condition is comparatively rare. But analysis of the statistics reveals the striking fact that, whilst the four largest hospitals together only reported a total of fifty cases for that period, two of the smaller hospitals admitted respectively sixty-one and twenty cases. Though it would be unfair to draw any far-reaching conclusion from these figures, they seem to support the view that the discovery of the disease depends upon keenness of search, for chance alone could not account for the great discrepancy in numbers at the different hospitals in the same city. Indeed there can be little doubt that the disease is much more common than English teaching allows. The ordinary routine of out-patient work furnishes a sufficient number of cases to make it incumbent upon the surgeon *always* to consider actinomycosis as a possibility in any chronic lesion. During the last three and a half years I have had under my care at least thirteen cases, and it is significant that by realizing some of the earlier signs of the condition, and making a routine examination for the fungus in chronic lesions, the number of cases has relatively increased; it cannot be doubted that previously cases were missed for want of sufficient investigation, or even because the very possibility of certain lesions being actinomycotic was not considered.

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* The published investigations of Woolf and Israel and of Homer Wright, and the recent unpublished researches of Colebrook, all point to this conclusion. So far as I am aware, Foulerton's work has not been confirmed, and the series of cases here presented lend little or no support to his views.

Source and Mode of Infection.—The fungus of actinomycosis is parasitic on, or has close connection with, certain cereals and grasses. It is not surprising, therefore, that herbivora, especially oxen, are prone to the disease. Most frequently it attacks the region of the lower jaw, and forms a very hard, tumour-like mass; sometimes it causes the 'wooden tongue' in cattle. It is unlikely, however, that human beings are often infected direct from cattle, for a large number of those who get the disease give no history of contact with animals. We can dismiss the theory that infection may be conveyed by tainted meat, on the grounds that very little infected meat is likely to pass the inspectors, and that cooking would certainly destroy the streptothrix. Nevertheless, undoubted cases of infection from living animals have been recorded, and one must therefore allow that this mode, though rare, is possible. Infection may occur direct from the vegetable which harbours the parasite. A lad (whose case is recorded below) tried to swallow a blade of grass, which stuck in his tonsil and formed an abscess which was lanced from inside the mouth. A month later an abscess formed at the angle of the jaw, from which actinomycotic granules were obtained, and from which a few days later the blade of grass escaped. Direct evidence of this kind is not as a rule forthcoming, nor do many of the patients tell of any habit of carrying bits of straw in the mouth. We must then look for some more generally applicable mode of infection.

The skin is not commonly affected primarily, so for practical consideration as to the mode of ingress of the fungus into the body there remain the alimentary and the respiratory passages. Infections in the region of the mouth are more numerous than all other cases put together. As contributing causes to this notable fact, we must remember (*a*) that the mouth is the part which first receives food, with any concomitant bacteria; (*b*) that there are many recesses and crevices around the teeth and in the tonsils which readily harbour microbes and sufficient particles of food to provide them with pabulum; (*c*) that the process of mastication provides many opportunities in the way of minute abrasions of mucous membrane for the fungus to enter the deeper tissues.

No one who has observed cases of peri-buccal actinomycosis can have failed to be struck by the association of carious teeth with the disease. Débris most readily collects around such teeth, especially in those who do not attend to dental hygiene. Some observers have demonstrated the presence of streptothrix in such débris. The intimate relationship between carious teeth and the disease is clearly shown in *Cases* 6 and 7 related below. In *Case* 7, the removal of a carious tooth allowed a probe to be passed easily into a large cystic cavity in the lower jaw which was filled with actinomycotic pus.

A case recently under my care gave most striking clinical confirmation of the theory of infection from carious teeth. During a fight with another man, a patient knocked out his opponent by a hard blow on the upper jaw. His fist struck against the other man's teeth and knocked some out, and a small superficial wound on the back of the hand was thereby caused. Inflammation ensued, and, after an acute stage, passed into an indolent condition. When first I saw the case there was considerable infiltration in the first

intermetacarpal space; from the discharging pus actinomycotic fungus was obtained.

The question as to how the fungus is conveyed to the mouth should not be difficult of answer. Many articles of diet are commonly packed in straw and eaten uncooked. Fresh fruit such as is usually eaten raw must be exposed to the risk of contamination from grass and straw in its conveyance from the field to the consumer. So it may be assumed that the streptothrix has many opportunities of access with ordinary food, and one need not invoke any habit of straw-chewing or grass-eating in most cases. It is clear, however, that those who live in the open country, and those in cities whose occupations entail the handling of hay or straw, are more exposed to infection. Gardeners, stablemen, fruiterers, warehousemen and packers, carmen, and carpenters would be amongst those more liable to the disease, either by direct digital contamination of food or by aerial transmission of the fungus.

The other parts of the alimentary tract from which infection may occur are the pharynx, œsophagus, and the cæcal region.

There are many arguments to support Poncet's view that the thorax is frequently infected by way of the œsophagus. For example, there is frequently a long interval at the commencement of the disease in which no pulmonary symptoms are noted, and it is at a late stage that the fungus is discovered in the sputum. Again, the location and mode of spread of the disease is suggestive of its origin from the mediastinum. Radiographs showing the earlier stages, and autopsies held on advanced cases of the disease, are both in keeping with this view. The way in which the process tracks back into the paravertebral groove or forward through the chest wall at the attachment of the diaphragm is easily explained if we adopt the theory of œsophageal infection. It is not sufficient evidence against this view that few œsophageal lesions are discovered, for in many undoubted cases of mouth-infection no lesion can be discovered in the buccal cavity at the time the disease comes under observation.

Infection from the stomach and small intestine is almost unknown. The acid gastric juice would either kill the fungus or inhibit its activity, whilst the fluid contents of the small intestine are unlikely to produce any abrasions through which the streptothrix might escape. In the cæcum, however, there is stagnation of the intestinal contents, and great multiplication of the bacterial flora, which from time to time assault the lining mucous membrane. An acute attack of appendicitis or typhlitis readily gives the opportunity for which the actinomycotic organism is waiting, and the latency of some forms of catarrhal appendicitis, which would nevertheless be sufficient to provide a mode of egress of the fungus into the tissues, may account for the extreme insidiousness of onset of some cases of actinomycotic appendicitis.

That the respiratory passages also provide an occasional path of entry, by means of spores or minute portions of mycelium floating in the inspired air, is indisputable; for cases are reported in which the lesions were confined to pulmonary tissue. These cases would be more likely to simulate tuberculosis of the lungs, and hardly come within the province of the surgeon.

CLINICAL PATHOLOGY.

Tissues Attacked.—The streptothrix of actinomycosis in a striking manner attacks some tissues in preference to others. Its best growth is seen in the connective tissues, especially subcutaneous, submucous, subperitoneal, and subpleural. The process extends nearly always by continuity in the

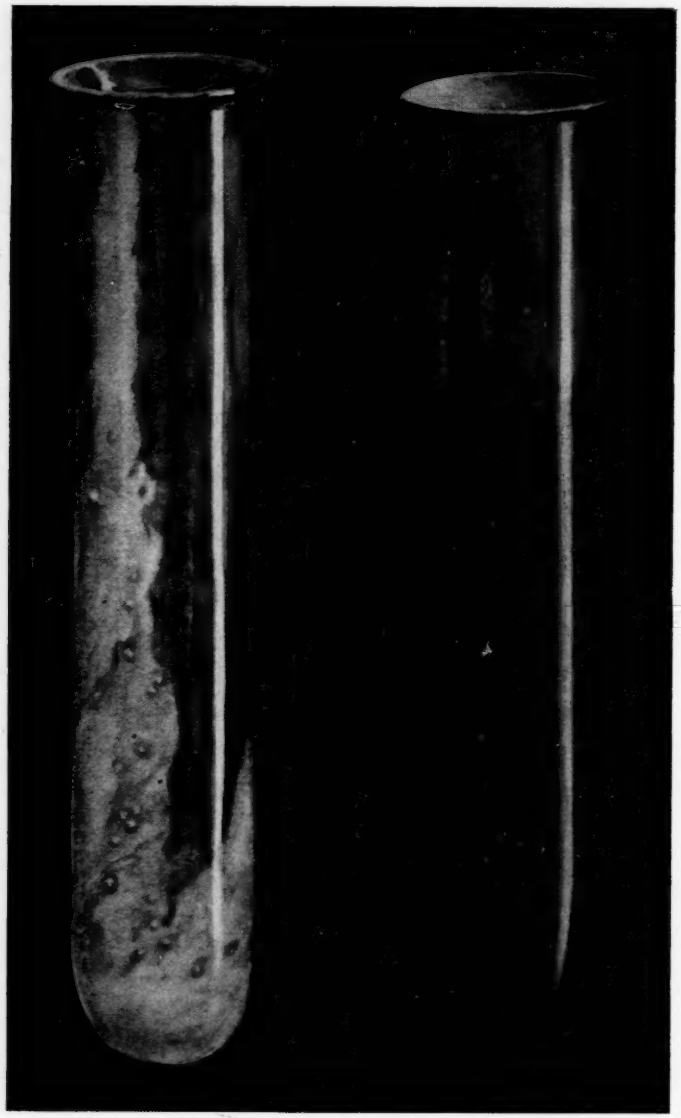


FIG. 13.—TEST-TUBE CONTAINING A LITTLE ACTINOMYCOTIC PUS, which has been poured down the side of the tube. Note the small granules which have stuck to the glass, and observe that no granules can be seen in the pus at the bottom, since there is nothing to contrast them against.

FIG. 14. — TEST - TUBE CONTAINING ACTINOMYCOTIC PUS MIXED WITH BLOOD (derived from the contents of the jaw abscess in *Case* 7), demonstrating how the yellow granules may show up against the general red ground.

connective tissues, seldom by the blood-stream, and hardly ever by the lymphatic system. Muscles are either pushed aside or infiltrated. Nerves may or may not be irritated by the disease. Bones may be superficially eroded by a contiguous focus. Primary bone infection is only seen in the jaws.

The skin is nearly always involved sooner or later, but offers greater resistance than the underlying tissues, for although sinuses develop, they show a tendency to close up before the underlying focus is extinct, and there is seldom much loss of skin leading to the formation of an ulcer. Possibly the preference of the organism for anaerobic conditions may partly account for this.

The lymphatic system is curiously immune to attack. The lymph glands are not enlarged, and do not appear to react in any way against the fungus. This fact serves to distinguish actinomycosis from other forms of infection, and especially from tubercle.

The peritoneum is resistant to attack; large masses of diseased tissue may form behind the peritoneum and bulge forward into its cavity without the serous lining permitting any to pass through; the retroperitoneal extension may be as far up as the diaphragm and as low as the pelvic muscular floor. When drainage of an actinomycotic abscess is carried out across the peritoneal cavity, the track of the tube becomes infiltrated with the disease, but peritonitis does not follow.

The course of the disease in the thorax lends support to the opinion that the pleura offers considerable resistance to the extension of the infection. The parietal abscess usually comes to the surface somewhere along the line of the attachment of the diaphragm, as though it had tracked along under the pleura. In one of the cases under my care (*Case* 10), thoracic infection was preceded by an empyema which left a large cavity that showed little attempt to heal up. When in a few months actinomycosis developed on the same side of the chest, it came to the surface underneath the left breast and in front of the cavity left by the empyema; the fungus did not break through the pleural wall of the empyema, and no streptothrix was obtained from the sinus.

Cases of primary actinomycotic infection of the genito-urinary system have been recorded, but are so rare that they must be regarded as curiosities.

Transmission by the blood-stream sometimes takes place, and metastatic abscesses have been found in the brain and kidney, etc.

Reaction of the Tissues.—When the streptothrix of actinomycosis grows in the tissues, it forms masses of mycelium of varying size—the granules of actinomycosis. These may be as large as a canary seed, or so small as hardly to be seen by the naked eye. The colour of the larger granules is often a mustard-yellow, but the smaller may be white, pinkish-grey or grey, or very pale yellow. *They can very easily escape notice when mixed with blood or liquid pus.* A good way to detect them is to allow the pus to flow down the sides of a sloping test-tube, for the granules adhere to the side of the tube, whilst the fluid part collects at the bottom. If the tube is held against a dark background the minute specks show up more readily (*Figs.* 13, 14). A magnifying glass may sometimes be used with advantage in their identification. The presence of the fungus in the tissues excites a reaction of varying intensity. In some cases the rapid growth of the streptothrix utterly disorganizes the

surrounding parts, which react by the formation of soft vascular granulation tissue. In other instances there is a characteristic formation of very dense fibrous tissue, which on section is almost cartilaginous in density. It may be possible to examine many sections of this tissue, both with the naked eye and under the microscope, without detecting any sign of the fungus; but if left alone, softening always occurs at one or more spots in the swelling, and the fungus may then be found in the softened area.

Vascularity of Lesions.—The vascularity of the lesions depends upon the nature of the tissue-reaction. In the soft variety there is a good blood-supply, but in the harder type the blood-vessels appear to be strangled by the contraction of the new fibrous tissue, so that the parts become avascular.

The Pus.—The only characteristic feature of the pus is the presence of the granules, and even these are not to be found at every stage of the disease. When the granules are very small and there is well-marked secondary infection, the pus as it escapes may appear just like that which comes from an ordinary abscess infected by staphylococci or other septic organism, whilst at other times, incision of a softened focus may not lead to the discovery of any true pus, but only a mixture of blood and granules. Sometimes the pus has a foul odour. When a large soft focus is opened, it presents a very characteristic appearance owing to the innumerable little yellow granules forming a sort of network throughout the soft flabby granulation tissue; it is as if canary seeds had been sprinkled through the vascular mass, which has the consistency of a soft fungating cancer. The term encephaloid might suitably be applied to such tissue.

Regional Distribution.—The regions attacked by actinomycosis may be grouped as follows:—(1) *Upper alimentary canal*: bucco-pharyngeal forms; (2) *Lower alimentary canal*: cæcal and appendicular infection; (3) *Thorax*; (4) *Miscellaneous*: skin, genito-urinary, etc.

CLINICAL SYMPTOMS.

The clinical symptoms vary considerably in different parts of the body, but in most cases two stages can be recognized: (*a*) The stage of induration; and (*b*) That of softening. Though the process is occasionally acute or subacute at the onset, it is essentially of a chronic nature.

1. **The Upper Alimentary Canal.**—The bucco-pharyngeal region is by far the most common to be infected primarily. This is not surprising, since any fungus introduced along with the food would here first have a chance of entering the tissues; the minute traumata caused by mastication would furnish frequent opportunities. Lesions may be found in almost any part abutting on the mucous membrane of the mouth and pharynx—the cheek, the parotid region, the submaxillary region, the tonsil, the tongue, the lower jaw, or the lower parts of the neck in relation to the pharynx. The upper jaw is rarely affected.

The site of development depends upon the place of inoculation; but though the latter is nearly always from the mucous side, the infective process, if occurring in soft tissues, generally spreads outwards towards the skin by the shortest or least resisting line of connective tissue.

When the tonsil is the path of infection, the process spreads downwards and backwards underneath the parotid gland till a swelling is formed in the interval between the angle of the jaw and the mastoid process. Possibly the stylo-maxillary ligament helps to prevent extension in other directions.

If infection takes place through the gums or teeth of the lower jaw, there may result a small induration on the outer aspect of the horizontal ramus, or a more extensive condition involving the cheek and parotid region—the most typical form of actinomycosis.

The lower jaw may be the seat of a primary focus which starts by the entry of the streptothrix through a diseased tooth socket. Submaxillary infection is undoubtedly in some cases the result of the fungus gaining access along Wharton's duct, but it is most likely that the more common mode of entry of the organism is through the mucous membrane of the floor of the mouth or alveolar margin. Infections lower down the neck, when they are not the continuation of a process which started in the buccal area, most likely track direct from the pharynx.

FIG. 15.—PHOTOGRAPH OF PERI-MANDIBULAR ACTINOMYCOSIS, which began about the time of eruption of the second permanent lower molar tooth. After causing a firm swelling for about three months, the process softened and discharged granules through a small sinus near the outer canthus of the eye. (*Under the care of my colleague, Mr. Maynard Smith, by whose kindness I was permitted to have the photograph taken.*)

In most cases it is impossible to demonstrate any breach of the mucous membrane through which the fungus might have entered, but it is frequently found that carious teeth are near to the region affected. In younger persons with perfect teeth, an opportunity of entry for the fungus may be furnished by the eruption of a tooth (*Fig.* 15). One observer has noticed that the eruption of the wisdom teeth is of special importance in this connection. I have had one patient in whom the disease developed near the wisdom tooth at the time of its eruption, and I have seen another in whom I blamed the second lower molar eruption for the starting of the condition. In slight cases of the disease, a limited smooth hard swelling may form in relation to the jaw, and within two or three weeks break down into an abscess. In the worst cases the induration is excessive, and a large mass of tissue as hard as wood may persist for a year or so with very slight softening. Most commonly the induration stage lasts for two to four months before softening is apparent.

There is generally much less swelling on the inside of the cheek or jaw, and it is rather uncommon for sinuses to open on to the interior of the mouth. Pain is most often relatively slight, and is altogether absent in the very chronic cases with marked induration. It is a marked feature, however, of the early subacute stage of the type which invades the parotid region. When a hard painless focus takes on a more rapid growth with softening, pain may be complained of.

Owing to the conditions of growth of the organism and the resistance which the skin offers to it, ulceration is seldom seen except in those cases where the surgeon has removed a considerable amount of the diseased tissue along with the overlying skin; in that case the raw surface shows little tendency to epithelialize over, unless quite healthy tissues form the base of the ulcer.

Secondary infection is common. The mouth contains many varieties of bacteria, and these frequently gain access to the tissues at the same time as the streptothrix. It is quite possible, and even likely, that septic organisms may in some instances prepare the way for the fungus of actinomycosis, just as we know they help the implantation of tetanus bacilli. Certainly they may give a much more acute character to the malady, and cause it to be mistaken for a mere septic infection. In the greater destruction and liquefaction of tissues which ensues with septic infection, the fungus may be difficult to find, and often appears degenerated and fragmented. The cellular tissues, however, can usually defend themselves against pyogenic microbes, and if the resulting abscess be drained adequately, the lesion subsides. But when the actinomycotic element is present also, the removal of the septic factor may allow it to grow in more typical fashion. Cases are undoubtedly missed because the initial examination of the pus may show a preponderance of other bacteria.

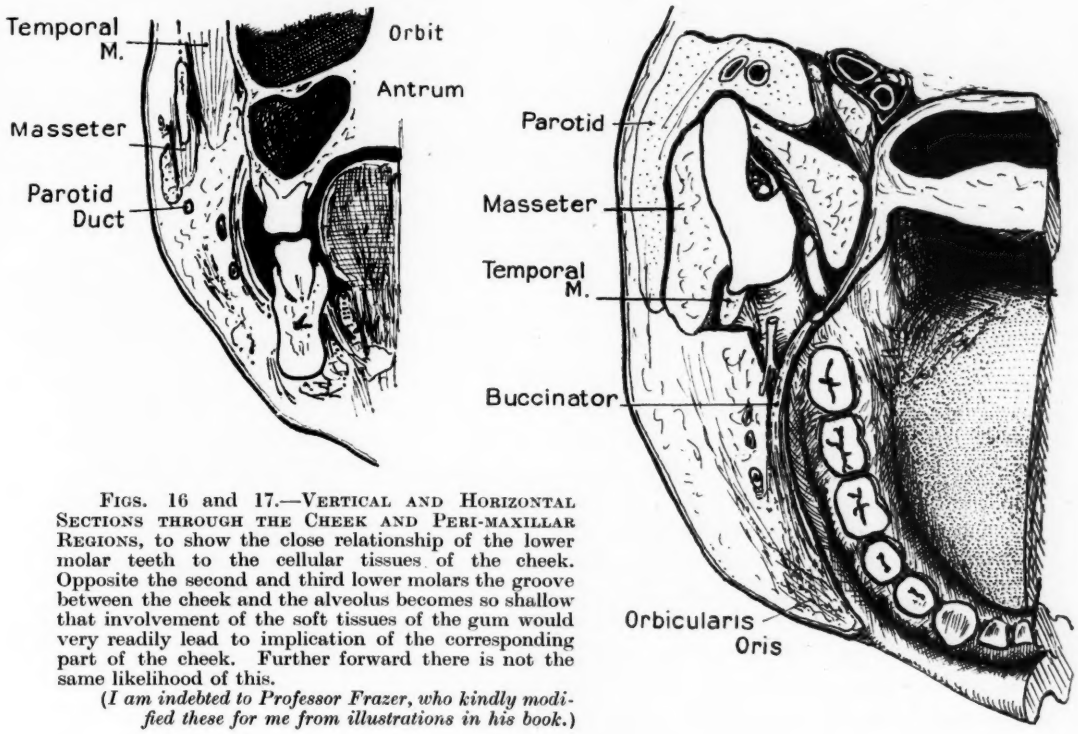
The skin over a buccal actinomycotic focus is usually unaffected for some time. The surface is smooth and the colour normal, or rather paler than normal, owing to the stretching of the superficial parts. A week or so before an abscess is going to burst, the skin becomes bluish-red or red, and fluctuation is obtainable.

A short description of that form of the disease which causes a swelling of the side of the face and the region of the angle of the jaw will serve to illustrate the main features of the condition as shown in one of its most common sites. The term cervico-facial as applied to it indicates the region affected; in many cases cervico-parotid would be more precise.

Clinical observation leads us to the belief that this form has its origin, in the majority of cases, through an entry of the fungus into the connective tissues of the gum near the lower molar teeth. In some cases the only abnormality discovered inside the mouth has been a carious lower molar or its stump. If the accompanying sketch of the vertical coronal section of the cheek and jaw region (*Fig.* 16), kindly drawn for me by Professor Frazer, be studied, it will be apparent that infection could readily extend into the cheek from a carious tooth which was worn down almost flush with the gums. The diagrams (*Figs.* 16, 17) also demonstrate the important fact that the cellular tissue of the cheek is more abundant, and has closer relationship with the alveolar margin of the jaw, than the similar tissue on the inner side of the horizontal ramus. This may account for the undoubted clinical fact that the actinomycotic process seldom extends much on the inner aspect of the jaw, but spreads freely throughout the cheek. We believe infection along the parotid duct to be a much rarer path of infection.

Cervico-facial actinomycosis is characterized by a swelling of the cheek which extends from the zygoma above to the inferior border of the mandible

below, and from the ear to the anterior border of the masseter. If it starts acutely or subacutely, the swelling during the first week is more diffuse and painful; pain is complained of in the region of the molar teeth and in the ear, and there may be tenderness on firm pressure over the swelling. When the process is chronic from the start, pain may be completely absent. In all cases, within three or four weeks a firm swelling is formed which has its maximum at the junction of the horizontal and ascending rami of the jaw. A marked symptom at this stage is trismus. The patient may not be able to open his teeth more than half an inch, and pain may be experienced in attempting to do more. The further course may be one of progressive hardening or softening. If the former, the swelling gradually indurates, and at the same time extends, till in



FIGS. 16 and 17.—VERTICAL AND HORIZONTAL SECTIONS THROUGH THE CHEEK AND PERI-MAXILLAR REGIONS, to show the close relationship of the lower molar teeth to the cellular tissues of the cheek. Opposite the second and third lower molars the groove between the cheek and the alveolus becomes so shallow that involvement of the soft tissues of the gum would very readily lead to implication of the corresponding part of the cheek. Further forward there is not the same likelihood of this.

(I am indebted to Professor Frazer, who kindly modified these for me from illustrations in his book.)

a few months the whole of the cheek, the parotid region, and the tissues over and below and behind the angle of the jaw form one solid mass of almost wooden consistency. The surface is smooth and forms a segment of a sphere, and pain is now neither complained of nor elicited on pressure. There is hardly anything in the range of surgery which has more characteristic features than such a swelling. The indurated mass sooner or later—after a time varying from two to four months—softens at one or more spots.

Softening nearly always occurs at the lower and posterior limit of the mass near the angle of the jaw, but occasionally it may be noticed at the upper limit near the zygoma or the eyelids. The resulting sinus discharges pus containing granules of the fungus. If the soft area be incised before the

abscess points definitely, no pus, but only blood and granulation-tissue débris, may be obtained. Aspiration by a needle is unlikely to draw off material of much use in diagnosis, because the granules of the fungus would have difficulty in traversing the needle.

A gradual migration of the inflammatory process towards the neck is noticeable. The path traversed is that of the subcutaneous connective tissues, for the deeper parts are not commonly invaded. The travelling border is of the soft type, and induration is rare at the advancing margin. New sinuses readily form in the new soft tissue, and frequently the old ones close up. Since there is considerable destruction of the subcutaneous tissues, the resulting scars are puckered. When several of these scars have been formed, the cervico-facial area presents a very characteristic appearance which is figured in some text-books. This represents, however, a late stage of the disease, often four to six months after the onset. Sometimes, but more rarely, the process tracks up to the temporal region, and a hard mass may infiltrate the temporal fossa.

Palpation of the interior of the cheek gives a better idea of the anterior limit of the disease, for it can be felt much more easily under the soft mucous membrane. The induration sometimes has a clear-cut anterior border which ends abruptly just in front of the anterior edge of the masseter. In extensive cases the soft parts on both sides of the ascending ramus of the jaw are swollen and hardened, but involvement of the tissues on the inner aspect of the jaw must be accounted rare.

The inferior maxilla may be affected, either primarily or as an event secondary to the form above described. The process in the bone corresponds to that in the soft tissues. The indurated form is represented by a chronic osteitis with much formation of firm cancellous bone traversed by small sinuses of soft tissue. The soft form is represented by a rarefying osteitis which may lead to a superficial erosion or to a central abscess. That variety which leads to the formation of much new and rather dense cancellous bone is accompanied by an affection of the soft tissues overlying the jaw. The course taken by the rarefying type of the disease varies considerably. In some cases the bone softens rapidly, and a track or sinus is soon formed which may burst through on to the cheek or gum; in others a very gradual expansion of the bone occurs, and new bone is formed on the outside as the softening destroys it on the inside. In the latter instance a large cystic swelling of the jaw develops after a period of many months. This swelling is firm, but as the expansion becomes more marked, egg-shell crackling may be elicited on firm pressure. A radiogram will show the cavity to be in intimate relation to the root of a carious tooth. In many cases where the situation and hardness of the swelling might lead one to think the mandible was involved, such is not the case. The upper jaw is still more rarely involved.

Though the tongue is very commonly the site of actinomycosis in cattle, it is rarely affected in men. A small firm nodule may develop, soften, and discharge granules. It has been asserted that healing occurs more readily in this region than in other parts.

2. **The Lower Alimentary Canal.**—From a surgical point of view appendicular and cæcal infection is the variety next in importance to the bucco-pharyngeal forms.

Clinically, two types can be recognized, which differ one from the other chiefly in the mode of onset.

The acute form starts with an acute attack of appendicitis, with perforation or gangrene of the appendix. Operation will not show anything atypical in the attack; the appendix is removed or an abscess drained in the usual way; but the sinus left by the drainage tube shows no tendency to heal up. As the weeks go by, induration of the walls of the sinus is observed, and if the iliac fossa be palpated, a firm swelling can be felt in relation to the cæcum. The indurated walls of the sinus can be felt to be continuous with the deep-seated mass. At this time it is possible the surgeon may explore the sinus to determine if there be any locked-up pus or a concretion or minute fæcal fistula to account for the condition; but he will find only a mass of firm tissue with softer parts in which dirty yellow specks may be seen. These specks are actinomycotic granules. Sometimes scraping the sinus will reveal them.

The chronic form, with insidious onset, first comes under the observation of the surgeon as a firm painless swelling in the right iliac fossa. Although no pain is felt locally, the infiltration of the adjoining iliopsoas may irritate the lumbar plexus, causing pain to be referred down the thigh. Persistent flexion of the hip may also result. The chronic pain in the thigh, with total absence of pain locally in the abdomen, can very easily mislead the observer. On exploration, the iliac swelling, in addition to hard tissue, will be found to have a softer nucleus containing actinomycotic granules. The soft material can be mistaken for the pus from an ordinary appendicular abscess which has become inspissated. The infiltration is retroperitoneal and may involve the psoas muscle deeply.

A third and pathologically interesting type is that in which the appendix, which has been removed for acute inflammation (without perforation), is found on examination to contain the fungus of actinomycosis. The acute inflammation is probably always caused by other organisms, and it is only when the wall of the appendix is perforated and the streptothrix has got into the cellular tissues, that one is justified in saying that actinomycosis is the dominant condition.

The further course of both main types is similar. The infecting process spreads slowly along the connective-tissue planes under the peritoneum; it may reach from the midriff to the pelvic floor. Large masses form in the loin and behind the ascending colon, pushing the latter structure forwards. Softening proceeds more rapidly in the newly-formed tissue, and abscesses need to be opened. Occasionally the process spreads under the peritoneum of the anterior abdominal wall as far as the umbilicus. Secondary infection is always present, and an irregular fever is the rule. The patient becomes markedly anæmic, and in fatal cases death occurs from exhaustion about a year after the condition has been detected. Recovery is always slow in the favourable cases.

3. **The Thorax.**—Apart from extension from the cervical region, there are two types of thoracic infection to be noticed. The first concerns only the air-passages, and gives rise to symptoms of bronchitis, or possibly bronchiectasis, in which the sputum may be fœtid; this form comes under the care of the physician. The second or perforating type is attended by much infiltra-

tion of the connective tissues of the mediastinum, and later of the thoracic wall; at the same time the lung—nearly always the lower part—may be extensively invaded by the disease. Cavities may form, and the condition simulate closely pulmonary phthisis. An abscess comes to the surface somewhere in the lower part of the chest, and on incision the fungus can be obtained from the pus. We have stated above our belief, founded on clinical grounds, that this variety is usually of œsophageal origin; it is the form which is likely to come to the surgeon for treatment on account of the superficial abscesses. Perforating thoracic actinomycosis is always of the soft type; the absence of any induration may be due to the great vascularity of the parts affected. Sooner or later, large tracts of the lung, pleura, and chest wall become infiltrated. Secondary infection is common. Lung symptoms are usually absent at first, and the first sign of anything seriously wrong may be a fluctuant swelling pointing over the lower part of the chest wall. On incision, a soft mass of readily bleeding granulation tissue is encountered, with a network of yellow granules in its midst. The appearance at first glance might suggest a fungating or sloughing sarcoma. Fever, anæmia, wasting, are noticeable features. Pain may or may not be present. Cough and expectoration may not develop till a late stage of the disease. The condition may spread subcutaneously over the thorax, and even across the axilla on to the arm; sometimes it invades the paravertebral groove posteriorly, and may cause abscesses which burrow through the erector spinæ. One side of the chest may be infected from the other by continuity of the disease across the front of the vertebral column.

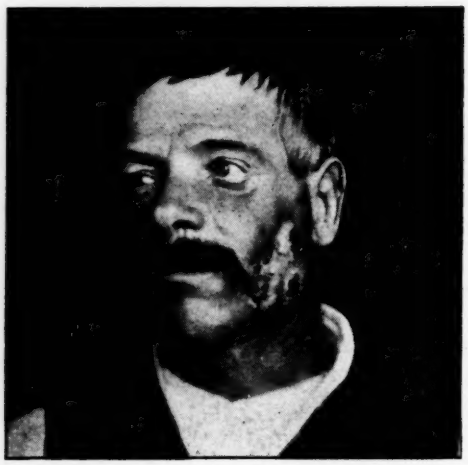


FIG. 18.—PHOTOGRAPH OF A CASE OF ACTINOMYCOSIS OF THE LEFT CHEEK CHIEFLY AFFECTING THE SKIN. This is rather a rare form. This patient was in St. Mary's Hospital in 1903, under the care of Mr. Collier, who effected a cure by excising the mass and skin-grafting the bare area later.

The perforating type of thoracic actinomycosis is usually fatal within a year of the first symptoms.

4. **Miscellaneous.**—Other varieties of actinomycosis are comparatively rare. The skin (*Fig.* 18) is resistant to infection; but occasionally (see *Case* 12) the subcutaneous tissues may be directly inoculated. Infection of the ovary has been recorded, and the lachrymal passages have been attacked. The liver also has fairly frequently been attacked, but it is difficult to believe that this is more than a metastasis from some other focus in the alimentary tract; it certainly has little surgical importance.

DIAGNOSIS.

There are many indications that in this country actinomycotic infection is often overlooked or misdiagnosed. Therefore, it is well at the outset to

remember that actinomycosis may simulate many other disorders. It is often easy to say of a lesion that it is actinomycotic; it is very often, if not usually, difficult to say that it is not due to the ray fungus. The disease may occur in the most unlikely situations and under various guises, so that the only safe rule is always to consider it when dealing with any chronic lesion, whether apparently neoplastic or inflammatory.

Of the two main types of actinomycosis, the hard and the soft, the latter is the less characteristic, but should be the easier to diagnose with certainty at an earlier stage, for softening leads to the formation of an abscess containing the typical granules. A routine examination of the discharge from all chronic abscesses is therefore the best and only certain way of diagnosing the condition early. It is true that sometimes no true pus is obtained on incision, but only soft débris mixed with blood; nevertheless the material from such an incision should always be subjected to microscopical examination.

The indurative type is clinically more definite, but from a pathological standpoint more difficult to confirm, because the hardness may persist and no material be available for examination for months after the beginning of the illness. Even when soft material can at last be obtained, the granules of fungus may be exceedingly small, or absent, and only degenerated atypical mycelium be discovered in small quantities, on account of the secondary infection. Sometimes the secondary organisms entirely overshadow the streptothrix infection, and it is only at a later stage that the latter become predominant and typical. Occasionally the fungus may not be found at the first examination, but at a second or third attempt it may be demonstrated.

In cases which provide no discharge, it may be suggested that the removal of a small portion of tissue for microscopical examination would elucidate the diagnosis. Far from this being so, many sections of the indurated tissue in cases of undoubted actinomycosis may be cut and yet reveal no sign of the fungus under the microscope. It would appear that the formation of fibrous tissue in such cases is so great that the fungus is entirely crushed out of existence in some parts of the swelling. When it is found in the sections, it may be in the form of the typical ray fungus, with the club-shaped feebly-staining bodies at the periphery of the mass of mycelium. It is at least possible that the clubs represent some change which the marginal portion of the mass has undergone under the hostile influence of the tissue surrounding it. The agglutination reaction has not been utilized to any extent in the diagnosis of actinomycosis, but may occasionally be of some value.

Considering, therefore, the few opportunities of pathological investigation in the early stage of the indurated form, and the ambiguity or uncertainty of such examinations, an additional importance attaches to the clinical symptoms. If there is a very suggestive clinical picture, but the pathological examination be negative, the clinical diagnosis can be maintained until further and repeated examinations finally prove or disprove the diagnosis.

The diagnosis of actinomycosis needs to be made from the other forms of chronic inflammation and from the various malignant and simple neoplasms. In the soft type it more nearly resembles septic, syphilitic, or tuberculous inflammation; in the indurative form it more often resembles a neoplasm.

Septic Lesions.—Purely septic lesions are more acute and more painful; on incision, drainage, and other appropriate treatment, they generally subside; or if the patient's resistance is poor, may extend rapidly, with symptoms of general intoxication, in a way never simulated by actinomycosis. Glands are frequently enlarged and painful, and the skin is usually reddened at an early stage, or an abscess soon forms, or an extensive cellulitis with brawny œdema of the superficial parts. Although actinomycosis is occasionally ushered in with acute symptoms, such is not the general rule, and it is frequently the accompanying septic organisms which are responsible for the acute symptoms. Accurate diagnosis is only possible by a microscopical examination of any discharge or pus obtained on incision.

Tuberculous lesions.—These can be compared with those due to actinomycosis as follows:—

	Tuberculous Lesions	Actinomycotic Lesions
Age	Occurs at any age from two years onward	Very rare under ten years of age. Occurs at any age after
Course	Chronic	The normal course would be accounted rather acute for tubercle
Lesions	Often multiple	Rarely more than one focus
Ulceration	Not uncommon	Uncommon
Lymph-glands	Commonly affected	Never affected
Sites	Skin, joints, bones, peritoneum are common sites	Skin, joints, bones and peritoneum rarely affected
Pus	Thin and yellow or caseous. No odour	Contains granules of fungus. Sometimes stinks
Scars	Weak, thin, and not puckered	Often very puckered
Pain	Usually absent	Often absent, but more likely to be present in stage of softening

Microscopical examination of the discharge will show the streptothrix in the one case, and may, but more often does not, reveal the bacillus of tuberculosis in the other; whilst sections of tissue may demonstrate giant-cell systems or clumps of the ray fungus respectively.

Syphilis.—The lesions of tertiary syphilis have to be distinguished from actinomycosis. A gumma is not painful in its development as are some of the more acute cases of the latter disease, and its progress is much more rapid. When softening occurs, a superficial gumma destroys a considerable amount of the overlying skin or mucous membrane, and forms an ulcer with a typical base which is unlike anything ever produced by actinomycosis. No granules are obtained, and the wash-leather sloughing area exposed is characteristic. Bones are more frequently affected by syphilis, and necrosis may follow. Other evidences of syphilis are often obtainable, and the Wassermann reaction may help. The value of the latter is chiefly of a negative nature, for a positive reaction does not exclude actinomycosis.

That form of tertiary syphilis which is accompanied by the formation of much dense fibrous tissue may present great difficulties until the course of the disease shows some determining factor. The differential diagnosis by observing the result of administering iodide of potassium is impossible, since both diseases are benefited thereby.

Neoplasms.—Some varieties of the hard form of actinomycosis can be mistaken for a fibroma or osteoma, sarcoma or carcinoma. The two former tumours are much slower in their formation, more circumscribed and distinct in outline, and do not soften like the lesions due to the ray fungus. A radiogram will determine the presence of an osteoma.

The only places where carcinoma is likely to be mistaken for actinomycosis, or vice versa, are the tongue and the cæcum. In the tongue, a small hard nodule might be due to either disease. If the condition did not soon give definite indications of its nature by the discharge of pus with granules, the possibility of cancer would require that the nodule should be excised and microscoped.

The neoplasm which is more likely than any other to be confounded with actinomycosis is sarcoma. Both the soft round-celled and the hard spindle-celled forms may be simulated. Sometimes the lesions are so hard that the surgeon may think he is dealing with an osteosarcoma. But a sarcoma at the outset is generally more definite in outline, and may present irregularities on the surface. Until the stage of softening has arrived, actinomycosis generally presents a smooth surface without any irregularities suggesting unequal growth, whilst the border merges insensibly into the surrounding tissues. In the case of sarcoma near bone, an *x*-ray photograph may show new bone formation or other characteristic appearance. With sarcoma, lymphatic glands are quite commonly involved (contrary to the view sometimes taught), whilst this is not the case with actinomycosis. Secondary growths occurring in other parts of the body would point to sarcoma. Finally, a microscopical section would serve to distinguish the chronic inflammatory process from the neoplastic formation.

Some cases in which large masses of actinomycotic tissue form a soft vascular swelling on the surface, as for example in thoracic cases, may easily be taken for fungating sarcoma. The best way to distinguish is by very careful examination of the softened tissue.

Diagnostic Features in Special Parts.

Region of the Lower Jaw and Face.—Here actinomycosis needs to be distinguished from the following :—

Simple Pyogenic Subcutaneous Abscess.—This is more acute in onset, more painful, usually subsides readily after draining, and the pus does not furnish the fungus granules.

Septic Periostitis and Alveolar Abscess.—This is much more painful and acute, is accompanied by more swelling of the gums, and soon leads to abscess.

Salivary Calculus.—Causes intermittent painful swelling in the submaxillary or parotid regions. Calculus may often be felt from the mouth. Softening does not follow.

Parotitis and Infection of the Submaxillary Gland.—Since infection with the streptothrix sometimes occurs along the ducts of Stenson and Wharton, it is clear that the initial symptoms may be exactly those of parotitis and submaxillaritis. In most cases of infection in these regions, however, the

salivary glands are not primarily involved. As a rule the swelling in actinomycosis is not confined to the area of the gland, and in a week or two the induration increases and the condition becomes more localized and definite. The internal openings of the ducts should be examined, and any escaping discharge microscoped.

Necrosis of the Jaw.—This condition, whether due to septic compound fracture, syphilis, acute periostitis, tubercle, or other cause, leads to a swelling something like that due to actinomycosis. The history helps much, and an *x*-ray plate more. It is noteworthy also that, with jaw necrosis, sinuses discharging pus are quite as likely to form on the inside of the mouth as exteriorly. This is not so common with streptothrix infection. Bare bone may be felt by the probe at the bottom of the sinus.

Cysts of the Lower Jaw.—These do not spontaneously suppurate and form sinuses, are more definite in outline, and can be distinguished by a radiogram. The rarefying form of actinomycosis may so expand the lower jaw as to form a large cystic space indistinguishable at first sight from a simple dental cyst. Both conditions are associated with carious teeth. A simple dental cyst is as commonly seen in connection with the upper jaw, whilst actinomycosis nearly always affects the lower jaw in the region of the molars. The only certain way to distinguish is by removing some of the fluid in the cyst and examining it carefully under the microscope.

A radiogram will detect an unerupted tooth in a dentigerous cyst.

Syphilitic Periostitis of the Mandible does not cause such dense or so extensive an induration, and may eventuate into a localized gumma or local necrosis of the jaw. In either case the distinction can be readily made by the history and clinical features, with the aid of a radiogram and a complement-fixation test for syphilis.

Tuberculosis of the Lower Jaw is very uncommon in the region of the angle. The process of the disease in the bone leads to the formation of small sequestra, which are extruded, or can be removed from time to time through the sinuses which form, both on the inner and outer aspect of the jaw. The pus which exudes from the sinuses does not contain any granules of the streptothrix. A history of tuberculosis in the same family may be obtainable. An *x*-ray photo will show the rarefaction and indistinctness of outline which is usually associated with tubercle in bone.

Inflammatory Phenomena associated with an Impacted Wisdom Tooth.—This may cause some difficulty in diagnosis. It is quite probable that the streptothrix sometimes gains access to the tissues through the abrasion caused by an erupting wisdom tooth, and at first there might be great difficulty in diagnosis. It is quite likely that the two conditions are often confused. As soon as softening has occurred, any doubt can be dispelled by examining the discharge.

Sarcoma.—It might be impossible to distinguish the early stage of a fibrosarcoma from a small nodule of actinomycosis. As a rule the sarcoma would stand out more prominently from the jaw and should have slightly more defined borders, whilst actinomycotic lesions cause a more diffuse swelling with indistinct border. A sarcoma may cause a symmetrical swelling on both aspects of the jaw; actinomycosis commonly affects only the outside. When softening occurs diagnosis is easy.

A myeloid sarcoma of the mandible should develop more slowly than actinomycosis; it would not cause infiltration of the cheek, and would be suspected when an *x*-ray photo was examined. Exploration might be necessary to distinguish it from that form of actinomycosis which expands the lower jaw and forms a large cyst.

Cæcal Region.—The form which follows an apparently ordinary attack of acute appendicitis is not likely to be diagnosed till some weeks have elapsed after the operation, unless the examination of the appendix showed the presence of the streptothrix. The persistent sinus will make the surgeon think of the possibility of the presence of a concretion, ligature, minute fæcal fistula, or ill-drained loculus of pus, to account for the condition. When the induration supervenes, the diagnosis will be suspected, and by this time the fungus granules will easily be discoverable by scrapings taken from the sinus.

That variety of the disease which has an insidious and chronic onset first presents itself as a hard tumour in the right iliac fossa. The conditions which would have to be considered in differential diagnosis would be: cancer, or the indurated form of tubercle, of the cæcum, osteoma or sarcoma of the ilium, and chronic appendicitis with thickening due to other organisms than the streptothrix. Exploration would be necessary in any case, for it would be nearly always impossible to decide without visual examination of the mass.

Thorax.—It would be out of place here to discuss the differential diagnosis of thoracic actinomycosis from pulmonary tuberculosis and neoplasms of the mediastinum or lung, other than to lay stress upon the facts that the streptothrix generally attacks the base of the lung, and tends to infiltrate and perforate the chest wall at the level of attachment of the diaphragm.

From the strictly surgical point of view, the simulation of abdominal disease by the condition is important. The intercostal nerves may be irritated, and pain be referred to the right or left hypochondrium. If on the right side, such pain may easily lead to a diagnosis of gall-stones or duodenal ulcer; in one of the cases recorded below, abdominal exploration was undertaken under the impression that one or the other was present. The signs found at the base of the lung may be interpreted as a subphrenic abscess, but a radiogram should show whether the lesion was above or below the diaphragm. When the disease has penetrated the chest wall a fungating sarcoma has been diagnosed; this mistake can be avoided if some of the softened material be examined carefully under the microscope. Generally, however, the appearance of the soft material is absolutely characteristic, the meshwork of fairly large granules in the red granulation tissue being unlike any other condition.

TREATMENT.

In certain parts of the body and under certain conditions, actinomycosis tends to recover naturally. Treatment yields best results in the face and neck regions. Lung actinomycosis of the penetrating type cannot be controlled by any means at our disposal, whilst when the cæcal region is affected the prognosis is not very much better. If the lesion is in a region where the whole affected area can be removed, the prognosis is very good.

The methods of treatment at our disposal are as follows:—

(1) Constitutional measures; (2) Medicinal drugs, especially potassium

iodide and other iodine preparations; (3) Antiseptics, applied locally; (4) Vaccine therapy; (5) Surgical operations; (6) Radiotherapy—*x*-rays and radium.

Constitutional treatment should be conducted on lines similar to those for tubercle. Good feeding and fresh air are most important in helping the body to resist any chronic infection.

Medicines.—Of the drugs used in treatment, the preparations of iodine are by far the most important. Potassium iodide has been vaunted as a specific for the condition. Whilst such a claim is demonstrably incorrect, there is no doubt that rapid improvement, with softening, often takes place under its influence, especially in buccal cases. It has been asserted that the drug acts by causing absorption of granulation tissue; its beneficial action in the granulomata of tertiary syphilis lends support to that view. To be of much value, the drug must be given in large doses up to as much as ninety grains a day. Other preparations of iodine, such as iodipin, have also been used by some, with beneficial effect; but the writer has no personal experience of their effect. The intravenous injection of salvarsan has been tried (*vide Case* 11) without any particular beneficial effect. Iron preparations may be necessary for the marked anæmia which develops in chest and abdominal cases.

Antiseptics.—Not much value can be attached to the local application of antiseptics to any open lesions which may be present. It is reasonable to apply a solution of iodine to any sinuses, and in view of the preference of the organism for anaerobic growth conditions, hydrogen peroxide is to be recommended as an application to abscess cavities.

Vaccine therapy is a valuable method of treatment, but, equally with other methods, fails to make much impression on extensive thoracic and abdominal cases. Vaccines are needed both for the streptothrix infection and for the secondary infection which is so commonly present. In both instances it is better to use an autogenous vaccine; but a stock vaccine may be utilized until the more efficacious preparation is ready. The dose of the actinomycotic vaccine must be carefully regulated by the reaction which occurs in the patient. It is wise to begin with small doses (say half a million fragments), and work up to that dose which seems best for the particular patient. Doses of more than fifty million have been given. The interval of dosage also varies according to the patient's reaction under treatment; the common interval is from three to seven days. The other vaccines which may be required depend upon the organisms found by a careful bacteriological examination.

Surgical measures comprise incision, excision, and scraping. Incision is required to let out any accumulation of soft material or pus. Excision of the whole infected area is sometimes, but rarely, possible, and is clearly the best treatment where no important structures are involved and a speedy cure is desired. Scraping of sinuses may be desirable occasionally, but scraping is at the best an expedient, and is seldom necessary.

X-rays were used in the treatment of some of the cases recorded below, but did not have any marked beneficial effect. Possibly softening is hastened by their aid, but certainly not to any great extent.

Radium was applied to one of the thoracic cases, with marked immediate benefit. A dose of forty-seven milligrammes was inserted into the middle

of the infiltrated base of the lung after resection of a rib, and was left in for twenty-four hours. The diseased tissues sloughed in large masses, and the change in the lung was appreciable. Whether the disease has to any extent been stayed is of course impossible to say yet.

SUMMARY OF CONCLUSIONS.

Actinomycosis is a disease common in London and the vicinity, and probably also in other parts of this country.

The condition is frequently overlooked and wrongly diagnosed as septic or syphilitic infection, or as sarcoma.

Actinomycosis should always be considered in the diagnosis in the case of any newly-formed subacute or chronic swelling in the region of the mouth, face, neck, thorax, or right side of the abdomen.

Infection with the fungus nearly always occurs from the alimentary tract.

There are two clinical forms of the disease, the hard and the soft. The hard variety softens after two or more months.

Pus from every abscess should be examined as a routine practice. In any sub-acute or chronic lesion, the discharge needs to be repeatedly examined.

Peri-buccal infections comprise the majority of the cases. Here the organism enters most often through the mucous membrane of the alveolar margin near a carious or erupting tooth, or through the tooth socket into the jaw.

The fungus is taken in with the food, and lodges round the teeth. The features of the hard peri-buccal form are very characteristic, and can often be diagnosed long before pathological investigation can give much help.

Treatment by the administration of iodides, by vaccine therapy, and by surgical measures, promises the best results.

ILLUSTRATIVE CASES.

I append brief accounts of thirteen cases of actinomycosis which have been under my care. Only one (*Case* 5) was referred to me with a diagnosis already made. All the rest were met with in the ordinary routine of out-patient and in-patient work. In eleven of the cases cultures of the streptothrix were obtained agreeing in most of the essential characteristics. I have not included any cases of infection with forms of streptothrix which did not lead to the formation of granules of the fungus in the tissues, and cases of infection with streptothrix differing in any other essential from the usual form have been excluded. The cultures were made by Dr. L. Colebrook, whose researches on the subject are as yet unpublished.

It is unnecessary to add that for the purposes of generalization the writer has profited by many other cases under the care of his colleagues which he has had the privilege of seeing.

Case 1.—**Actinomycosis behind angle of jaw. Infection of tonsil.**

F. H., age 10. The patient came to hospital complaining of pain in his throat. He stated that he had tried to swallow some grass, but it stuck in his throat. The house physician incised the right tonsil, which was swollen. Within three or four days a swelling developed behind the right angle of the jaw, so he was referred to me

in the out-patient department. Within a month softening occurred, and an abscess was opened externally from which typical granules were obtained. Later the piece of grass was discharged from the sinus. A good recovery occurred and the boy continues well.

Case 2.—**Submaxillary actinomycosis**

F. C., age 18. The patient was sent up from Herne Bay to St. Mary's Hospital, in 1912, because of a swelling in the right submaxillary region which had been developing for some weeks ; a molar tooth had been extracted previously to my seeing him. Examination showed a very hard, painless mass of tissue in the right submaxillary and submental regions. The edges of the swelling were not very definite, and the skin over it was normal in colour. Treatment was continued in the out-patient department for several weeks, but no improvement occurred, so he was sent into the hospital under the care of my colleague on November 4, 1912, with the diagnosis of actinomycosis. An incision was made, but no pus obtained, so the whole mass was excised. The submaxillary gland was found intact underneath the mass. Microscopic sections of the hard tissue showed a typical actinomycotic focus, the peripheral club-forms being very characteristic.

FIG. 19.—*Case* 6. PHOTOGRAPH SHOWING THE SMOOTH SWELLING OF THE CHEEK, most marked over the angle of the jaw.

Case 3.—**Cervico-facial actinomycosis.**

H. E., male, age 31. Occupation, carman; lives at Hayes, in Middlesex. Came to hospital in November, 1913, because of swelling of the right side of the face, and inability to open mouth properly. When first seen there was a diffuse, rather soft and painful swelling covering the parotid region and extending downward to the angle of the jaw and forward to the centre of the cheek. At first the diagnosis made was acute parotitis, but in a week or so the swelling became firmer, less diffuse, and localized to the region of the angle of the jaw. Softening occurred, and an abscess was lanced. Granules of actinomycotic fungus were obtained. The disease spread downwards along the line of the sternomastoid muscle, and subsided in the original area with the formation of puckered scars. Secondary infection with both cocci and bacilli was present.

Treatment by vaccine was successful. He is now perfectly well.

Case 4.—**Peri-mandibular actinomycosis.**

J. F., male, age 21, living in West London, by occupation a timekeeper on the Great Western Railway. When first I saw him, there was a firm smooth swelling extending upward and forward from the region of the right angle of the jaw. Marked trismus was present, severe pain in front of the ear, and some pain on pressing the swelling. The condition had been thought to be due to a wisdom tooth which was erupting. Extraction of the tooth had brought no relief. Actinomycosis was diagnosed, and when softening occurred in May, 1914, the material from the abscess was examined bacteriologically. Only *Bacillus fusiformis* was detected—no mycelium. The clinical condition was too definitely actinomycotic for one examination to suffice. Further investigations in June showed streptococci in the discharge, and a little atypical mycelium was found. At the end of July, three months after the clinical diagnosis was made with assurance, incision into a softened focus liberated material containing some definite actinomycotic granules. There were bacilli and cocci also present.

The disease was treated by potassium iodide and a vaccine of the fungus. Cure resulted in a few months. He is now quite well.

FIG. 20.—*Case* 6. COLOURED SKETCH (from life) OF THE SOFTENED AREA. An incision had recently been made and some gelatinous material wiped away. The central red area is therefore denuded of skin and shows the underlying granulation tissue. Granules of the fungus embedded in this tissue can be seen remarkably well. The surrounding livid area represents the soft actinomycotic focus covered by thinned skin. It must be remembered that it is rare for ulcers to occur naturally in the course of the disease.

(*I wish to express my indebtedness to Mr. R. Clyne for the coloured illustrations* (*Figs.* 13, 14 *and* 20), *and for photographs* (*Figs.* 19 *and* 22).

Case 5.—**Mandibular and peri-mandibular actinomycosis.**

G. E., male, age 19. Occupation, labourer; lives at Melton Mowbray. In the summer of 1912, the patient was treated at Leicester Infirmary for an abscess in the region of the left side of the lower jaw. A tooth was removed, and incisions made both from outside and within the mouth. The diagnosis at that time was parotid infection derived from a septic tooth. Later, Dr. Smyth, of Melton,

diagnosed actinomycosis, and gave potassium iodide internally. The swelling continued hard and discharged a little at intervals. There was hardly any pain.

In January, 1914, he was admitted to St. Mary's Hospital under the care of Sir A. E. Wright. At that time he was a well-nourished man ; he complained of no pain, and had no general symptoms such as fever. There was a very large swelling centered about the ascending ramus of left lower jaw, very fixed to deep structures, but not to skin, and almost of bony hardness. It extended up to and beneath the zygoma. Scar near the angle of jaw with a little pus beneath. The pus contained granules of the streptothrix of actinomycosis as well as secondary organisms.

Treatment by *x* rays did little good, and potassium iodide in large doses caused little improvement, so I was consulted as to surgical intervention.

On April 9, 1914, a large part of the dense fibrous swelling was removed. It was intimately attached to the periosteum of the jaw. The outer lamella of the mandible was also chiselled away ; the interior of the bone was traversed by many small sinuses filled with granulation tissue. A carious tooth and the tonsil on the affected side were also removed. The tooth had a small carious cavity in the middle of its crown ; some Gram-positive filaments suggestive of actinomycosis were found on it. One piece of filament suggestive of actinomycosis was also found in a tonsillar crypt. The mass removed was very dense and avascular, like cartilage.

FIG. 21.—*Case* 6. RADIOGRAM OF THE JAW. This shows a condition of osteoperiostitis at the angle of the jaw. The carious stump of the second right lower molar tooth can be clearly seen. The affection of the bone is secondary to that of the soft tissues.

Improvement followed operation, but the swelling recurred again. The disease is still active three years after its onset, though lately *x* rays have caused some improvement.

Case 6.—**Peri-mandibular actinomycosis.**

G. N., male, age 19. Occupation, a tailor. Came for advice to the Bolingbroke Hospital, December 19, 1914, on account of a swelling of the right side of the face which had been developing for six weeks. His doctor had made an incision near the angle of the jaw, and a small sinus was still there. There was a large indurated swelling with centre near the angle of the jaw, with redness and superficial softening at the lower border of the mandible (*Figs.* 19, 20, 21). He could not open his mouth more than half an inch. Very slight or no pain on pressure. His teeth were good, except for a right lower molar, of which the decayed stump was still present, and a corresponding upper molar. Actinomycosis was diagnosed, and immediately confirmed by scraping the sinus and examining a stained film under the microscope. Treatment by potassium iodide is causing marked improvement.

Case 7.—**Actinomycosis of the lower jaw with large central abscess.**

Gladys K., age 16, consulted me at the Bolingbroke Hospital in January, 1915, for a swelling of the left side of the lower jaw (*Figs.* 22, 23). She stated that the swelling had been growing for the last twelve months, but that it had been getting much bigger just lately. Examination showed a swelling projecting from the outer aspect of the horizontal ramus of the mandible and extending from the position of the canine to the second lower molar tooth. The second bicuspid and first molar teeth in relation to the upper part of the swelling were carious, and only the stumps remained. The tumour was very hard and somewhat irregular on the surface. No fluctuation was felt anywhere, and the skin was free. At the first examination I diagnosed either a new growth (osteoma or sarcoma), or, in view of the carious teeth,

actinomycosis. The *x*-ray examination seemed to favour sarcoma. On February 13 the swelling was explored under an anæsthetic. On clearing the periosteum from the lower border of the mandible in the affected area, pus escaped from the interior of the cystic jaw through an opening caused by erosion of the bone, and the characteristic actinomycotic granules were at once seen. The carious stumps were removed, and it was found possible to pass a probe from the socket of the extracted teeth into the abscess cavity and out through the exploration opening. Immediate microscopic confirmation of the nature of the granules was obtained.

This case seems to prove clearly the relationship of carious teeth to jaw infection. The marked expansion and rarefaction of the interior of the bone left so thin an outer layer, that egg-shell crackling was noticed on pressing on the jaw while operating.

FIG. 22.—*Case* 7. PHOTOGRAPH SHOWING THE SWELLING CAUSED BY THE CYSTIC EXPANSION OF THE LEFT HORIZONTAL RAMUS.

Case 8.—**Ileocæcal case. Acute type.**

D. R., female, age 16, was admitted to St. Mary's Hospital, November, 1912, with symptoms pointing to acute appendicitis. Operation revealed a perforated appendix with local suppuration. The appendix was removed, and drainage instituted. Convalescence was uneventful save that the sinus persisted. In January, 1913, the sinus still caused trouble and was indurated, and a firm swelling was felt in the iliac fossa, so the track was scraped under an anæsthetic, and a search for a local abscess made. The scrapings looked like and proved to be actinomycotic matter. She was transferred to the care of Sir A. E. Wright and treated by vaccines. Counter-openings in the loin were necessary later, but the patient improved greatly, and now, after two years' treatment, has but a small sinus left. At one time this patient was seriously anæmic, but she has now recovered her strength.

FIG. 23.—*Case* 7. *X*-RAY PHOTOGRAPH OF THE LOWER JAW, showing a large cystic expansion of the left horizontal ramus, caused by actinomycosis. The second bicuspid and first molar teeth were carious, and the stumps which remained led right into the large abscess cavity. Egg-shell crackling was obtained on firm pressure. The swelling was all on the outside of the jaw, the buccal aspect felt normal on palpation. The arrow points to carious stumps.

Case 9.—**Ileocæcal case. Chronic type.**

Mrs. N., age 45, was sent to hospital from Hendon on December 19, 1911, because of severe pain in the right thigh. Her doctor stated she had ailed since October 12, when she had a febrile attack with muscular pains and headache. The fever subsided and she got about her work again; but on November 20, when she again consulted her doctor, the temperature was 101°, and she complained of constant aching pain in the right thigh. The temperature persisted for a month, and the patient became weaker and kept her right thigh flexed.

When admitted to hospital, December 20, 1911, her temperature was 101°.

Complexion sallow. Complained of pain in front of right thigh just above knee. Hip was flexed 30° or 40°, and could not be straightened without producing lordosis. Other movements at hip, except those that would stretch psoas, normal.

No abdominal pain. Definite lump felt in abdomen above Poupart's ligament in the iliac fossa; no pain or tenderness on pressure. Pelvis normal. No urinary troubles. Chronic appendicitis was diagnosed.

December 23, 1911. Operation revealed a chronic abscess with inspissated material, behind and internal to cæcum (*vide Fig.* 24). Base of appendix normal, but it led into abscess cavity situated behind the mesentery, which was common to ileum and cæcum. The stump of the appendix was removed and the abscess cavity drained. The walls of abscess were very firm. Psoas was infiltrated with cartilage-like induration.

January 20, 1912. Sinus track indurated. Temperature still elevated. Opsonic index to tubercle 1·38.

January 31, 1912. Sinus scraped. Actinomycotic filaments found in scrapings.

The patient was then transferred to the care of Sir A. E. Wright. She remained in the hospital many months and was treated by vaccines. Her temperature was very irregular, and secondary infection was ascertained. The disease extended upwards, outwards, and downwards, but the peritoneum was not invaded. The colon was pushed forwards by the retroperitoneal swelling. The general condition gradually became worse, and death ultimately took place in July, 1912, from septic bronchopneumonia. On several occasions an attempt was made to find the organism in the blood, but without success. The patient's serum had a high agglutinating reaction to the infecting streptothrix.

FIG. 24.—*Case* 9. DIAGRAM SHOWING POSITION OF RETROCÆCAL ACTINOMYCOTIC ABSCESS (*shaded area*).

At the autopsy, actinomycotic infiltration was found to extend behind the peritoneum up as far as the diaphragm and down into the pelvis. The extent of this infiltration was remarkable, and was described in the post-mortem record as follows: "The retroperitoneal tissues of the posterior abdominal wall and the posterior and lateral walls of the pelvis were necrotic and infiltrated with thick pus. The condition extended upwards in and around the psoas muscles of both sides as high as the upper poles of the kidneys, while on the left side it spread over the front of the hip-joint into Scarpa's triangle and the inner side of the thigh."

Case 10.—**Thoracic actinomycosis.**

A. W., female, age 42. No other illness. Two brothers and a sister were said to have died of phthisis; one brother now in Infirmary. Had worked amongst straw in unpacking goods for her employer. Husband was a coachman.

The patient was admitted to the medical wards at St. Mary's Hospital in September, 1911, for pleuropneumonia. On October 29 she was transferred to the surgical wards for left-sided empyema. This was opened and drained by resection of part of the 7th rib.

Bacteriological examination of the pus revealed only pneumococci. After three weeks the patient was discharged well except that the sinus had not healed up. For five months patient carried out her ordinary duties in spite of the slight inconvenience of the sinus.

In March, 1913, a swelling developed below and external to the left breast. Within three weeks this softened and burst. On April 12, exploration under an anæsthetic showed several intercostal spaces to be infiltrated with granulation tissue which bled readily and contained many yellow specks, which on microscopic examination proved to be the mycelium of actinomycosis. Apparently there was no connection with the empyema sinus.

On April 16, patient was transferred to the care of Sir A. E. Wright. At the time of transference the notes state that she was thin and sallow and had an "earthy

cachexia." Slight pyorrhœa, carious lower-teeth, irregular temperature, furred tongue, and dry hacking cough were noted. The lower part of the left chest was dull on percussion, and air entry was diminished. Several other organisms were found in addition to the streptothrix of actinomycosis.

Treatment by vaccines and potassium iodide was tried, and some improvement occurred at first. In October, 1913, further lesions developed in the left axilla, and in the upper part of the left breast and chest wall. Severe pain felt down arm. Temperature still very irregular, from 98° to 102°.

November, 1913. Actinomycotic streptothrix found in sputum. December, *x* rays tried (diffused through aluminium sheet). January, 1914. Vaccines stopped. Lesion spread posteriorly. February, vaccines restarted. Gradually became worse. Pulse varied from 120 to 140. Temperature from 98° to 102°. Death occurred on May 31.

At the autopsy on June 2, both lungs were found to be diseased. The lower part of the left lung was solid with actinomycotic disease, and this lung was totally adherent to the chest wall. There was consolidation of the right upper lobe, with cavity formation, and many small abscesses which proved to be actinomycotic. There was a connecting track of diseased tissue between the two sides, which had eroded the dorsal vertebræ. The only other focus of actinomycosis was a small area under the capsule of the left kidney. Marked amyloid disease was present in spleen and intestine — less marked in liver.

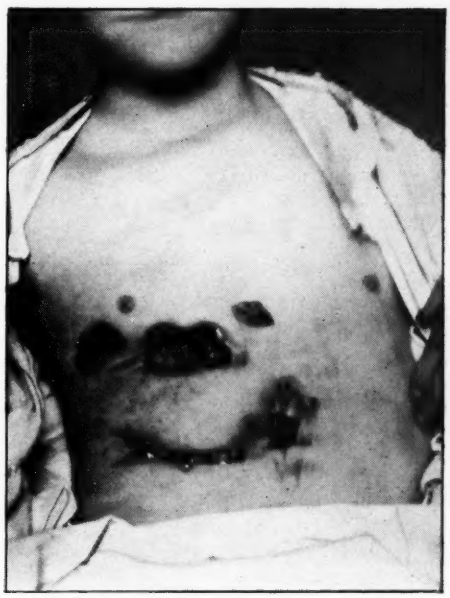


FIG. 25.—*Case* 12. PHOTOGRAPH OF THE FRONT OF THE CHEST, showing the fungating growth of actinomycotic material which had perforated the chest wall. Radium was inserted into the midst of the infiltrated lung through the upper opening.

Case 11.—**Thoracic actinomycosis.**

H. B., male, age 29. Occupation in a woollen warehouse in London.

First sign of illness in November, 1913, when severe pain developed in the right hypochondrium and behind right shoulder. The pain persisted till I first saw him on December 1, when I made a provisional diagnosis of gall-stones. At the time there was tenderness and some rigidity in the right hypochondrium. No jaundice, vomiting, hæmatemesis, or melæna. Leucocytes, 11,500 per cubic millimetre. Pain in right shoulder subsided, but persisted in hypochondrium. He was feverish. Examination of chest showed dullness and impaired air-entry at right base, and *x* rays showed an abnormal area below right lung base. Exploration of pleura by needle did not reveal any fluid or pus. A physician who saw the case in consultation with me thought possibly a subphrenic abscess was present.

December 12. Exploratory abdominal section. Liver reached down to umbilicus. Gall-bladder distended. No gall-stones. Cholecystostomy performed. After operation, the pain in the back of the right chest still persisted. It was a constant aching or boring pain.

January 19, 1914. A large fluctuating swelling detected in the right loin and over the lower right ribs posteriorly. Patient about this time coughed up a lot of thick sputum which was not examined.

January 23. Large abscess opened and drained. Foul-smelling green pus came away. Thicker material near the ribs communicated with the interior of

thorax through 11th intercostal space; actinomycotic granules were found in the pus. After operation patient spat up a little sputum and blood containing granules.

Patient transferred to the care of Sir A. E. Wright. The condition became gradually more extensive, and in spite of inoculation and other methods of treatment, death occurred in October, 1914. The infection spread upwards in the para-vertebral groove, and an abscess developed on the right side of the vertebral column. An autopsy was not obtained.

Case 12.—**Thoracic actinomycosis.**

B. K., a girl, age 13, living in North-west London, had right-sided pleurisy in May, 1914. This attack apparently passed off. During the second week of July she felt pain in the lower front of the right side of the chest; a week later a cough developed, but there was no sputum. On July 29 a swelling was for the first time noticed over the lower part of the right chest in front. Patient was admitted to hospital August 1, 1914. When admitted did not seem very ill. Her temperature reached 100° each evening. There was a swelling extending from the right margin of the sternum to 1½ inches external to the right vertical nipple line, and reaching from the third to the seventh costal cartilage; it was dull on percussion and tender to the touch. A systolic murmur was heard at the level of the fifth costal cartilage near the margin of the sternum. Exploration of the swelling by a needle only withdrew blood. There was a leucocyte count of 20,000.

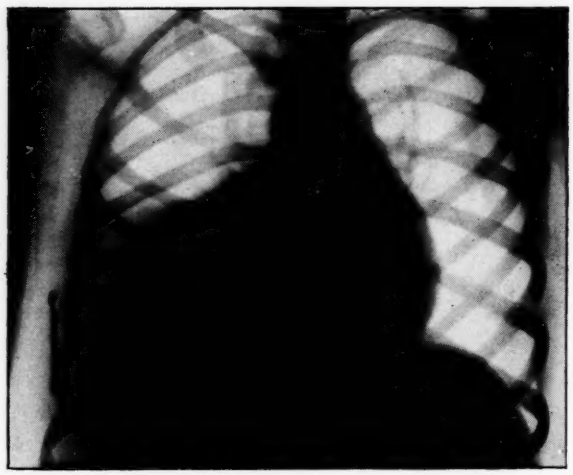


FIG. 26.—*Case* 12. RADIOGRAM OF THE CHEST, showing infiltration of the whole lower part of the right lung and adjacent mediastinum. No treatment by radium had yet been undertaken.

On August 28, 1914, the case was transferred to my charge. Incision of the swelling under an anæsthetic showed it to be composed of soft friable vascular tissue somewhat resembling a soft sarcoma. A little of this material was microscoped, and reported to contain some cells suggestive of round-celled sarcoma. For some weeks after this, the temperature persisted and the general condition became worse, so on October 1 a more extensive operation was done and a large mass of the diseased tissue removed. At this time the appearance was such that I felt sure the condition was actinomycotic, and this surmise was confirmed by bacteriological examination. On October 16 she was transferred to the care of Sir Almroth Wright. She has been treated by vaccines with some, but not marked, benefit, and lately the insertion of radium into the midst of the diseased lung has been followed by some improvement. The first application of radium was followed by considerable sloughing of the infiltrated part of the lung. The patient is still under treatment. The appearance of the chest before the application of 47 mgrams of radium is seen in the accompanying radiogram (*Fig.* 26).

Case 13.—**Actinomycosis of hand.**

T. B., male, age 27. Was sent to hospital by his doctor because of an indolent inflammation of the right hand. It appeared that three months previously, in a fight with another man, he had knocked out some of his opponent's front teeth with a strong right-handed blow. Two days later acute inflammation set in, and extended

up the arm; but soon the acute symptoms subsided, and the process became more localized and chronic. Several incisions had been made to let out pus, but the condition still persisted.

When first I saw him in March, 1914, there were several healed scars on the dorsal aspect of the first and second intermetacarpal spaces of the right hand. The skin was unhealthy-looking, and the subcutaneous tissues were the seat of what appeared to be an ordinary subacute septic infection. A discharging sinus was present. An incision was made, and some of the material obtained sent in the usual way for microscopical examination. Actinomycotic granules and mycelium were discovered. Patient was referred for treatment to the department for therapeutic immunization, and was given appropriate vaccine treatment. Within a month the condition was properly healed up. When last seen, February 1, 1915, his hand had remained perfectly well, and the only traces of the old trouble were the healthy white scars of incisions and a slight limitation of movement at the metacarpo-phalangeal joint of the first finger.

UNILATERAL HÆMORRHAGE AND UNILATERAL PAIN OF RENAL ORIGIN.

By CUTHBERT WALLACE and LEONARD S. DUDGEON.

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The publication of the following cases has been prompted by the articles contributed by David Newman and Gilbert Barling in this Journal (July, 1913, and April, 1914).

In the first place they confirm what is already well known, that nephritis may cause a unilateral hæmaturia which clears up after operation. In addition, they seem to suggest that a nephritis may at one time give rise to pain and at another to hæmorrhage.

Case 1.

S. H., male, age 40, a farmer, was admitted Feb. 10, 1914, with a history of nine weeks painless and almost constant hæmaturia. The previous history was unimportant. The urine was of a dark reddish-brown tinge, the specific gravity was 1020, and the amount passed in the twenty-four hours averaged 26 ounces, containing about 300 grains of urea. Microscopical examination showed blood discs, but no casts or tubercle bacilli. The cystoscope showed that the left ureter was discharging blood-stained urine at frequent intervals, and that the right ureter discharged normal urine at less frequent intervals. Indigo-carmine came through, deeply coloured, in ten minutes. The kidney was exposed through the loin and incised into the pelvis through its convex border. There was nothing abnormal to the naked eye either in the pelvis or in the cut surface. A portion was removed for examination. The patient was discharged on April 2, with normal urine.

Microscopically, no thickening of the capsule was present, but small areas of fibrosis were scattered through the renal tissue, while a few of the glomeruli are represented by nodules of fibrous tissue. The chief microscopical changes in the kidney, however, are to be met with in the epithelial cells of the tubules. Here we find the renal epithelium, especially of the convoluted tubules, showing all stages of degeneration. In close proximity to the apparently normal cells are others which are swollen, distended, granular, and without a nucleus, whilst others show ragged edges and are greatly increased in size as compared with the normal cells. As a result of these changes in the epithelium of the tubules, the lumen in the affected areas is blocked with shed epithelial cells and granular débris. The duct tubules are, however, apparently normal.

Case 2.

J. B., male, age 45, a timber porter, was admitted in October, 1913, with an intermittent hæmaturia of four years' duration. There was a history of

fractured ribs about the same time as the onset of the bleeding; but the patient's wife was sure that the hæmaturia had preceded the accident. Five months before admission the patient was attacked with pleurisy, from which he made a good recovery. There had been frequency of micturition for three months.

During the whole illness there had been a dull backache. The hæmorrhage was profuse at times, and clots would form in the bladder. Sometimes the blood would be intimately mixed with the urine; at other times it would occur only at the commencement of micturition. Sometimes the bleeding would be absent for as long as a fortnight. Skiagrams of the genito-urinary tract showed nothing abnormal. The urine was acid, 1012, and contained a few pus cells, but no casts. The amount passed in twenty-four hours was about 30 ounces.

FIG. 27.—*Case* 2.

The cystoscope showed a normal bladder, but copious hæmorrhage from the right ureter. The urine from both ureters was deeply coloured with indigo-carmine within fifteen minutes, the patient being under an anæsthetic. On October 22 the right kidney was exposed and opened along the convex border. There was nothing abnormal to the naked eye, either in the cut surface or in the pelvis. A small vein crossed the posterior surface of the junction of the pelvis and ureter, and possibly slightly constricted the canal. On November 8 the urine was free from blood. On November 26, when the patient was discharged, the urine was acid, 1010, and contained some pus cells, but no blood.

In this case (*Fig.* 27) the renal capsule is very much thickened, quite four times as thick as the normal capsule. There is little to be noted about the glomeruli, and apart from the capsular fibrosis, no abnormal fibrous deposits are to be found in the various sections of the kidney. The main change concerns the tubules, more especially the convoluted and allied types. Many of the cells are swollen and distended with granular material, and such cells are generally devoid of a nucleus; but all stages are met with, from this extreme degree to the apparently healthy cell. The lumen of the tubules

contains granular material, and a solid effusion which gives rise to considerable dilatation. Some of the epithelial cells are vacuolated, but in other areas a similar appearance is produced by a vacuolation of the exudate which is present in the interior of the tubules. It is important to distinguish between the true vacuolation of the epithelial cells and the false vacuolation of the exudate in the tubules.

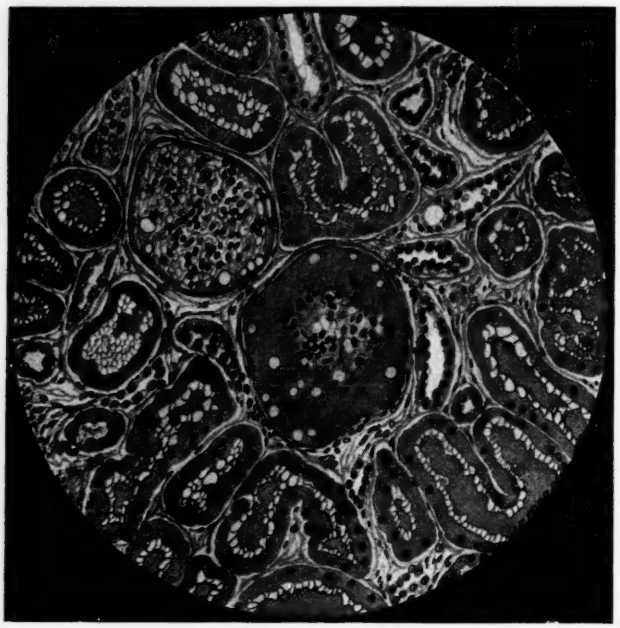

FIG. 28.—*Case* 3.

Case 3.

A. S., male, age 28, chemist, admitted with a history of eighteen months' duration. He complained of a dull fixed pain situated on a line drawn from the umbilicus to the anterior superior spine, but rather nearer the former than the latter spot. He had taken morphia to relieve the pain. Physical examination was negative. The *x* rays showed a doubtful shadow in the region of the pelvis of the left kidney. The urine was acid, 1008, with a slight cloud of albumin. There were no casts, but a few pus cells and oxalate crystals were detected. The amount of urine passed in the twenty-four hours varied from 26 to 76 ounces. Cystoscopic examination showed normal bladder and ureters. Nephrotomy was performed, but nothing abnormal was detected in the kidney or its pelvis. A portion of the upper part of the organ was taken for examination. The pain ceased entirely after the operation.

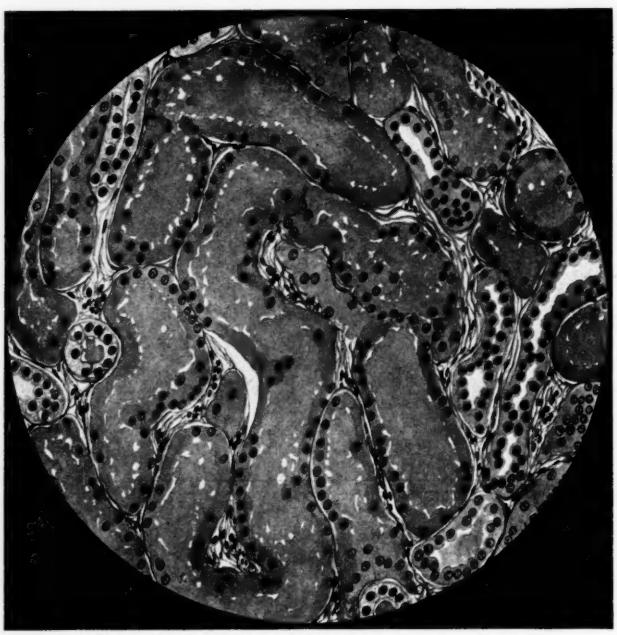

FIG. 29.—*Case* 3.

There is no increase of capsular connective tissue present, and no fibrosis in any area of the renal tissue examined; but an area of cellular infiltration is present, which consists chiefly of round cells and also of small spindle cells (*Figs.* 28, 29). This cellular infiltration extends along the connective-tissue septa between the tubules for a limited extent only, and partly compresses the adjacent renal tissue. The chief change, however, is confined to the tubules. Abundant coagulated material is present in many of the chief functionating tubules, completely obstructing the lumen. This material is also present in many of the glomeruli. The capsules are thus rendered particularly prominent, producing an appearance as if the walls were enormously thickened. The capillary tufts are compressed into a central bunch, or to one side, according to the amount of exudate present in the capsules. In some of the tubules the exudate is retracted so as to produce an appearance suggestive of vacuolation of the cells of the tubules, which moreover is present in the epithelial cells of the convoluted tubules. Many cells of the convoluted and allied tubules show degenerative changes—from complete absence of nucleus in a cell, together with a ragged outline and swollen appearance, to changes of a comparatively slight degree. The duct tubules show no change; but in the lumen of some the exudate which gives such a striking appearance to the glomeruli and to the other tubules can be readily recognized. No arterial changes can be detected.

In *Case* 3, a cultivation of the renal tissue which was removed at operation was carried out. In this instance a short-chained streptococcus was obtained in pure culture, which acidified and clotted milk and acidified many of the sugar media, in which it grew with a uniform turbidity, such as is usually met with in the case of streptococci with feeble or no pathogenicity for the lower animals. In this instance a large quantity of a young culture of this streptococcus was inoculated into two mice intraperitoneally, but failed to produce the slightest effect. The mice were killed six days after the inoculation, and the kidneys examined microscopically; but they were found to be perfectly healthy.

Case 4.

G. W., male, age 37, a general labourer, gave a history of a year's duration. The pain was sometimes dull, sometimes paroxysmal, and was referred to a spot midway between the umbilicus and the anterior superior spine. It shot through to the back, but never down the leg or into the testicle. Physical and *x*-ray examination of the kidney and pelvis was negative. Cystoscopic examination showed a normal bladder and ureters, which passed frequent jets of clear urine. Indigo-carmine came through deeply coloured within ten minutes of injection. Phthalein test gave 40 and 20 per cent in the first and second hour respectively.

The urine had a specific gravity of 1008. The amount passed in the twenty-four hours varied from 16 to 59 ounces. There were no casts, albumin, or sugar. Nephrotomy was performed, and the kidney hemisected along the convex border. Both kidney and pelvis were normal to the naked eye. A portion of the top pole was taken for examination. The pain ceased entirely after the operation.

No thickening of the capsule; but small scattered areas of fibrosis are present in sections of the kidney (*Figs.* 30, 31). In one of these foci, which is immediately subcapsular, the glomerulus is completely atrophied, and replaced by dense fibrous tissue; there is also atrophy of the tubules, whilst such tubules as are present show fibrosis of the walls; in fact, this microscopical area of the kidney must be practically inert. A few of the glomeruli elsewhere are completely replaced by fibrous tissue, while many of the capsular walls show distinct thickening of the connective-tissue coat. Some of the capsules contain sufficient effusion to compress the capillaries more or less severely. Three microscopical calculi are present in a distended tubule, together with shed epithelial cells and red blood-corpuscles. It is in the tubules that the most marked changes are to be witnessed, more especially in the convoluted as compared to the duct tubules. Many of the epithelial cells lining the walls of these spaces are apparently perfectly normal cells, but the adjoining cells may be swollen, with ragged edges and without a nucleus. The lumen of many of the tubules is filled with granular material, which is no doubt partly formed from the shed epithelial cells of these tubules.

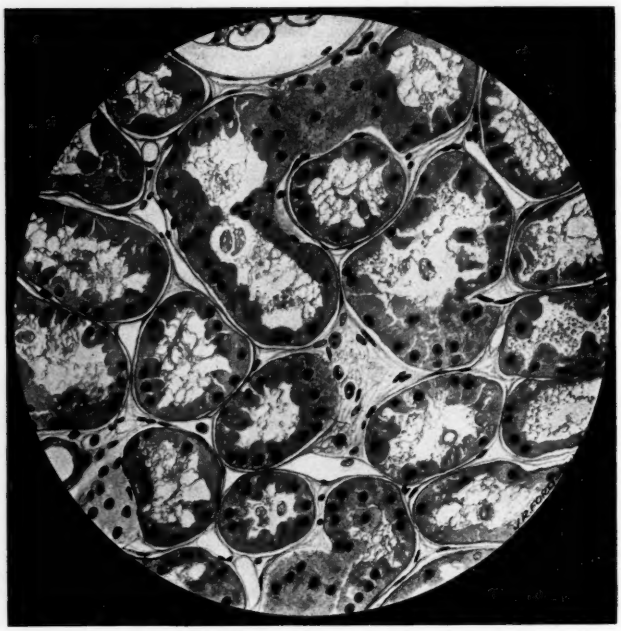

FIG. 30.—*Case* 4.

FIG. 31.—*Case* 4.

The changes found in the above four cases may be summarized as follows :—

GROUP I.—

HÆMATURIA.

Case 1.—Urine 1020. 26 ounces in twenty-four hours. Acid. No casts. Albumin and blood discs from left kidney. Urea, 300 gr. Indigo-carmine through, deeply coloured, in ten minutes.

HISTOLOGY.—Small scattered areas of fibrosis in the cortex. A few glomeruli were fibrous. Many cells of the convoluted tubules were swollen, distended, and granular. Lumina were blocked with the débris. Duct tubules were normal.

Case 2.—Urine 1012. 30 ounces passed in twenty-four hours. Acid. No casts. Much blood and albumin from right kidney. Indigo-carmine through (from both sides), deeply coloured, in fifteen minutes (patient under anæsthetic).

HISTOLOGY.—Renal capsule much thickened (four times normal). Some fibrosis of glomeruli. Cells of convoluted tubules swollen and distended with granular material. Lumina filled with granular débris and a solid effusion.

Vacuolation of many cells and vacuolation of the solid effusion.

GROUP II.—

NEPHRALGIA.

Case 3.—Urine 1000. Acid. Some albumin. Amount in twenty-four hours about 50 ounces. No casts. Oxalate crystals. A few pus cells. No increase in connective tissue.

HISTOLOGY.—Some small round-celled infiltration. Cells of convoluted tubules showed degeneration, with absence of nuclei in some of the cells. Abundant coagulated material in the lumina and capsules, compressing the capillary tufts and producing an appearance of enormous thickening in the wall of the capsule. Some exudate in the duct tubules. A streptococcus was found in pure culture ; it was non-pathogenic to mice.

Case 4.—Urine 1008. Neutral. No albumin. Amount in twenty-four hours was 57 ounces. No casts. Indigo-carmine through, deeply coloured, in ten minutes. Phthalein 40 per cent first hour, 20 per cent second hour.

HISTOLOGY.—No thickening of capsule. Small scattered areas of fibrosis showing atrophied glomeruli and tubules. Effusion into the capsules, compressing the capillaries. Cells of convoluted tubules in many instances were swollen, ragged in outline, and without nuclei. Lumina of tubules filled with granular material and epithelial cells.

It is essential to realize that the observations which form the basis of this paper result from an inquiry into the renal changes met with in portions of kidney removed *during life*, and placed in a suitable fixative almost immediately after removal from the body. In two instances the renal tissue was fixed in bichromate formalin. In the other two cases salt formalin was used

instead. Sections were cut and stained by those methods which were likely to throw light on the condition which was present.

All who have had experience of post-mortem pathology are well acquainted with the fact that alterations of varying degree are met with constantly in the renal epithelium, more especially that of the convoluted tubules, so that slight alteration in these epithelial cells cannot be taken too seriously. But it is also the epithelium of the convoluted tubules which shows the pronounced changes from which the kidney tissue is so liable to suffer in the various toxæmias to which the human tissues are liable and which can be excited experimentally in animals.

The four cases may be divided clinically into two groups, though histologically the two groups are in the main similar. In the first two hæmaturia was the cause for which advice was sought; in the second group, pain.

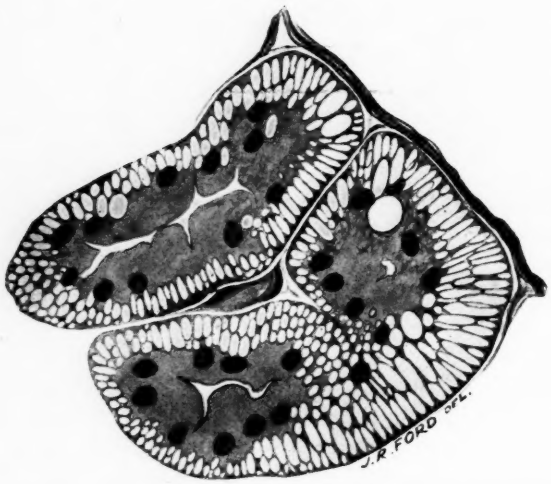

FIG. 32.—TOXIC VACUOLATION OF RENAL CELLS.

Two cortical tubules beneath capsule. Kidney of guinea-pig treated with blood-serum of guinea-pig prepared by injection of renal extract of a series of guinea-pigs. ($\frac{1}{6}$ *obj.*)

The cases of both groups have a common histological feature, namely, a disintegration of the cells of the convoluted tubules, though the two cases forming each respective group were not similar in other details. Thus *Case* 2, *Group I*, and *Case* 3, *Group II*, both showed effusion of solid material and vacuolation of cells, though *Case* 1 and *Case* 4 showed no such change.

The absence of casts is remarkable in all four cases. The tests of renal efficiency, so far as they were tried, showed no departure from the normal in any instance. The specific gravity of the urine was low in the second group.

The etiological facts to explain the symptoms of the patients and the changes met with in the renal tissue are entirely wanting, but some information may be offered to explain the vacuolation in the tubules which is seen in *Cases* 2 and 3 (*Figs.* 27 and 28).

In a paper published by Castaigne and Rathery,[1] vacuolation of the renal cells was described as the result of the injection of an iso-nephrolysin. Shattock and Dudgeon obtained the most striking vacuolation of the renal epithelium in guinea-pigs with an iso-nephrolysin, and as their investigations have not been published it may be as well to refer briefly to them.

The guinea-pigs' kidneys which formed the antigen were freed from blood as far as this is possible by careful washing with saline by means of a cannula in the thoracic aorta. Guinea-pigs were then inoculated in batches with either a renal extract or minced kidney injected through a Bashford syringe.

In due course the blood from both batches of animals was injected intra-peritoneally into other guinea-pigs, and the results carefully noted. In each case a marked vacuolation of the hepatic cells and of the epithelium of the convoluted tubules occurred from the injection of the isolysin.

In the kidney, as the accompanying diagram fully illustrates (*Fig.* 32), the vacuolation is especially marked towards the base of the cytoplasm, while the nuclei remain intact.

Shattock and Dudgeon, as a result of a complete investigation of the changes in kidney and liver, considered that they were of a dropsical nature, produced by the isolysin.

As anæsthesia had to be employed in these experiments, it might be suggested that the changes were dependent upon the toxic action of the ether; but such an idea can be excluded, as guinea-pigs fully anæsthetized for one hour with ether fail to show any such change in the liver or kidneys.

It is essential to distinguish between vacuolation of the renal cells and a vacuolation of the coagulable material which may occur in the lumen of the tubule.

In our two cases, the vacuolation of the contained products is especially marked, while vacuolation of the renal cells is much less obvious.

The distinction between the two classes of vacuolation can be very clearly appreciated by comparing *Figs.* 27 and 28 with *Fig.* 32, which represents the experimental lesions.

In the experimental cases, the vacuolation of the kidney cells was produced by a toxin artificially introduced into the circulation. There was a similar vacuolation in two of the clinical cases under notice. It may therefore be suggested that here also the vacuolation was produced by a toxin in the blood which, in addition, we may suppose, caused the nephritis. The difficulty in accepting this explanation is the one-sided nature of the lesion in the clinical cases, as suggested by the clearing up of the symptoms after nephrotomy; but the evidence that the condition was unilateral is only apparent, and cannot be accepted as a positive fact.

REFERENCE.

[1] Castaigne and Rathery, "Lésions des Reins produites par Injection d'Émulsion Rénale ou de Sérum Nephro-toxique," *Compt. rend. de la Soc. de Méd.*, pp. 563–565.

OBSERVATIONS ON THE MYELOID TUMOUR OF TENDON SHEATHS.

By M. J. STEWART and E. R. FLINT, Leeds.

The first recorded case of a non-osseous myeloid tumour was that described by Broca[1] in 1860. During the ensuing twenty-five years only 4 more cases were placed on record, but since the middle eighties the number of published cases has rapidly increased, and in 1913 Tourneux[39] was able to collect no fewer than 54 examples from the literature. Eight new cases have been published since that date, which, with the 2 here described, and 9 others from the literature not included in Tourneux's list, brings the total up to 73. Of these, fully two-thirds have been recorded by French and German authors.* The first English communication on the subject was one by Targett[16] in 1897, entitled *Giant-celled Tumours of the Integuments*, wherein he described 4 cases in considerable detail. No specific mention is made, however, of any relation to tendon sheaths, and the opinion is expressed that the tumours took origin from the deep fascia. Four years later, in 1901, Bellamy[26] reviewed the literature up to that date, and published 4 original cases which he had studied in Stilling's laboratory at Berne. The literature was again reviewed by Tourneux in 1913; but both he and Bellamy appear to have been unaware of Targett's communication.

Up to this time (1913) writers were unanimous in regarding these tumours as true neoplasms, although there was some divergence of opinion as to their precise nature. Heurteux[10] (1891) first attempted a systematic study of the whole subject, and concluded that they were divisible into two groups: (1) Those composed chiefly of embryonic cells, with embryonic vessels, and characterized by rapid growth and a tendency to the invasion of surrounding structures, i.e., true sarcomas; and (2) Those in which the myeloplaxes were associated with an adult type of stroma, and in which growth was slow, while the tumour remained purely local. These latter should be classified as myelomas, along with the bony tumours bearing this name. Targett[16] (1897) regarded his cases as spindle-cell sarcomata, and was clearly at a loss to explain the presence of the giant cells. He concludes thus: "Their relation to the inflammatory processes need not be discussed, for these tumours were not tuberculous, nor syphilitic, nor granulomatous; clinically as well as histologically they were malignant growths."

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* The actual geographical distribution, as indicated by the country in which the cases were published, is as follows:—

Germany	26
France	24
Italy	12
Great Britain	7
Switzerland	4

Dor[20] (1898) was the first to describe the presence of xanthoma cells in a myeloid tumour of tendon sheath. He concluded that he had to do with a mixed tumour composed of xanthomatous and myeloid tissues, and suggested the name myeloxanthoma. The two types of cell, myeloid giant cell and xanthoma cell, he regarded as due to specialized development, along different lines, of one common ancestor. Bellamy[26] (1901), from a detailed study of four cases, concluded that the growths were endotheliomatous in nature, and applied to them the term myeloid endothelioma. Tourneux[39] (1913) concluded that they were sarcomatous new growths of low malignancy; that they were definitely malignant if inefficiently treated he had no doubt.

In the same year an important contribution to the subject was made by Fleissig[35] (1913), who advanced the thesis that these tumours were granulomatous in nature, and not neoplastic as had been held by all former writers. He based his conclusions on finding areas in the tumour with the typical structure of granulation tissue, on the presence of lipoid-containing xanthoma cells, and on the occurrence in one of his cases of deposits of crystalline cholesterin, with foreign-body giant cells in the neighbourhood. From the presence of cholesterin crystals and xanthoma cells, Fleissig suggested that cholesterin might be associated in some way with the genesis of the tumour. A similar view as to the etiology was put forward by Spiess[36] (1913), who, however, believed the growths to be sarcomatous in nature.

Grant and Stewart[38] (1914) regarded their case as essentially endotheliomatous, a 'myeloid endothelioma,' while Shaw Dunn,[40] in the course of some remarks following the reading of their communication, expressed the view that these tumours "were on the border line between tumour growth and granulomatous formation. . . . The giant cells were related to the presence of cholesterin crystals."

The cases we now wish to place on record are typical examples of this peculiar form of new growth, and are of great interest from several points of view. *Case* 1 was that of an invalided Belgian soldier in whom the tumour was successfully diagnosed clinically, with the result that we were able to utilize the material to the best advantage. In *Case* 2 the correct diagnosis was arrived at only after histological examination of the excised growth had been carried out.*

Case 1.

Francois S., age 27, a soldier of the Second Belgian Grenadier Regiment, was admitted to the Leeds General Infirmary, under the care of Sir Berkeley Moynihan, in October, 1914, suffering from generalized pain and stiffness in the limbs, especially the right arm and leg, contracted during the trench fighting in Flanders.

In the course of examination a small tumour was found on the ulnar aspect of the right thumb. The patient stated that it had first appeared some seven or eight years before, and two or three years after he had had an injury to the thumb. This injury, the scar of which is still visible, was a deep wound of the dorsal aspect of the proximal phalanx, and was caused by a saw wielded by a fellow workman.

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* For permission to publish these cases we are indebted respectively to Sir Berkeley Moynihan (*Case* 1), and to Mr. Douglas Seaton and Dr. E. Allan Wilson (*Case* 2).

The tumour was situated on the lateral (ulnar) aspect of the thumb opposite the distal two-thirds of the proximal phalanx (*Fig.* 33). It extended nearly to the middle line both in front and behind, and was clearly not fixed to the bone. The skin over it was thick and tough, and appeared to be slightly adherent in the centre, although freely movable at the margin. The scar of the former injury, situated on the dorsum, ran upwards and slightly outwards from the base of the tumour. A diagnosis of myeloid tumour of tendon sheath was made, and, at our suggestion, the patient readily consented to have the growth excised.

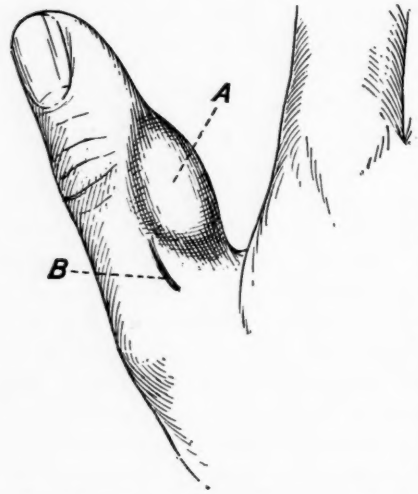

FIG. 33.—*Case* 1. THE TUMOUR (A) *in situ*.
The scar of the old injury is indicated at B.

An incision was made on the antero-lateral aspect of the thumb, the skin having first been anæsthetized with cocaine (0·5 per cent) and adrenalin (1-1000). The tissues at the base of the thumb were also blown out with the same fluid in such a manner as to make a complete ring of distention. The incision included an ellipse of skin to which the tumour appeared to be somewhat adherent. The capsule of the growth was exposed, and little by little the more superficial bulky part was freed and found to be attached to a pedicle which came out between the proximal phalanx and the tendon of the flexor longus pollicis. This pedicle was now seen to be attached to the lateral aspect of the sheath of the tendon, and to that part of it which lies against the bone; but nowhere was there any attachment to the bone itself. The tumour was removed by cutting away a narrow margin of healthy sheath all round. One or two catgut stitches partially closed the gap in the tendon sheath, and the skin sutures completed the operation.

The wound healed by first intention, and by the end of a few weeks the movements of the thumb were regained perfectly.

The growth on removal measured about one inch in length, three-quarters of an inch in breadth, and a quarter of an inch in thickness. It was markedly lobulated, and very irregular in shape. On section, it consisted of a number of lobules of varying size, separated by strands of fibrous tissue of varying width (*Fig.* 34). The larger lobules were in the central part of the growth, and were of a translucent greyish or slightly greyish-yellow colour, while at the periphery were numerous lobules of much smaller size. Some of the latter showed little streaks and patches of yellow or brown, especially at the periphery, but otherwise they had the same translucent greyish appearance as the larger lobules. The tumour was exceedingly firm in consistency, and cut with considerable difficulty.

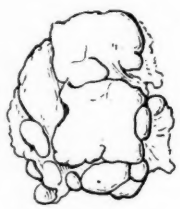

FIG. 34.—*Case* 1. SECTION THROUGH THE TUMOUR AFTER REMOVAL, showing lobulation.
(*Natural size.*)

Histology.—

1. *Paraffin Sections, formalin- and alcohol-fixed.*—The tumour is broken up into lobules by dense bands of fibrous tissue, which substance also provides a capsule for the growth. The structure of the individual lobules is definitely alveolar, and at the same time densely fibrous. The alveoli vary greatly in size, and contain varying numbers of tumour cells. The latter are spheroidal and polygonal for the most part, but tend to be flattened out by pressure of the surrounding fibrous tissue. The smaller alveoli are fully occupied by tumour cells; the larger frequently show a mass of cells at the

periphery, and a space in the centre. In addition, multinucleated giant cells of the 'myeloid' type are present in considerable numbers, and are scattered with great uniformity throughout the growth. The stroma is composed of wavy bundles of dense fibrous tissue, varying in number and in thickness in different parts of the tumour. The structure is, in our opinion, that of an endothelioma (*Fig.* 35).

The *endothelial cells* which fill the alveoli are, as stated, mainly spheroidal or polygonal in shape, and they have round, oval, or polygonal nuclei of very uniform size, each with a single nucleolus. In the smaller alveoli, and wherever the fibrous stroma is in excess, the tumour cells tend to become com-

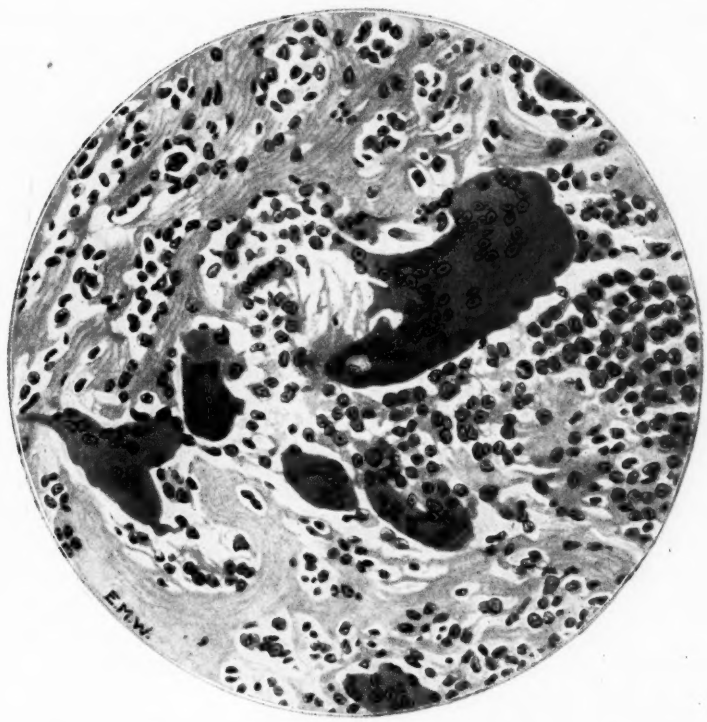

FIG. 35.—*Case* 1. SECTION OF TUMOUR, showing several giant cells in the midst of an endotheliomatous type of growth. (× 250.)

pressed and distorted, while the nuclei become oval or even spindle-shaped. Mitotic figures are occasionally seen in the more cellular portions of the growth.

The *giant cells* are very variable in size and shape, but otherwise present uniform characters. Morphologically they are identical with those seen in the more fibrous forms of myeloid sarcoma of bone, especially the so-called myeloid epulis of the jaw. The nuclei are numerous, and uniform in size, being slightly smaller than those of the endothelial cells. The cytoplasm is granular, and stains deeply with eosin. The smallest giant cells contain only two or three nuclei, and are only very slightly larger than the endothelial cells; but they can always be readily distinguished by their strongly eosinophilic cytoplasm. If, as contended by Bellamy, the giant cells are formed

from the endothelial cells (as by fusion), which seems very probable, some very definite change in the chemical constitution of the cytoplasm takes place in the process. This is further borne out by the staining reactions with Mallory's acid fuchsin—aniline blue—orange G combination, which stains the cytoplasm of the endothelial cells blue or greyish-blue, that of the giant cells (be they ever so small) a peculiar orange-yellow or bluish orange-yellow colour, while bringing out at the same time their granular quality.

Sections stained with van Gieson are chiefly of use for demonstrating the amount and distribution of the fibrous stroma. The masses of endothelial cells lying within the alveoli are in some cases permeated by pink-stained fibrillæ, but more often this is absent.

A large number of paraffin sections examined show no evidence of cholesterin clefts, either in the substance of the growth or at the periphery. In this latter situation, however, there are numerous collections of golden-yellow pigment, presumably the result of former hæmorrhage, while similar small collections are seen here and there in the substance of the growth. The pigment, which gives a well-marked Prussian-blue reaction, is largely intracellular, and when it occurs within the substance of the tumour proper, part of it appears to be contained within both the endothelial and the giant cells of the growth, a further indication of their common origin.

2. *Frozen Sections, formalin-fixed.*—These were stained with Nile-blue sulphate A in the cold for fifteen to twenty minutes, and were then well washed in water.

Examination with the polarizing microscope shows a complete absence of doubly refracting lipoids, either as plates, prisms, or anisotropic globules, in the cellular (parenchymatous) parts of the growth. In the surrounding zone of fibrous tissue, especially where it is dense and where hæmorrhages have occurred, a number of tiny anisotropic globules are seen, and a small amount of (?) amorphous doubly-refracting material. This encapsuling fibrous tissue, as well as that within the tumour lobules, is itself the seat of faint stabile double refraction. That is to say, this optical property of the fibrous tissue is unaffected by lipoid solvents, and is consequently seen in both paraffin and frozen sections. The effect under the low power, which is very striking, is that of tabby-cat striation.

In the Nile-blue sections, the masses of endothelial cells have rather feebly-stained cytoplasm, with a very pale nucleus containing a tiny dark nucleolus. The giant cells have deeply-stained cytoplasm, but the same clear nuclei with small dark nucleoli. There is no evidence, in any part of the tumour, of pink-stained neutral fat, an observation which is confirmed by the examination of sections stained with scarlet R. Some of the pigment masses stain a bright orange with this stain, but the great bulk are unstained, and show only the yellowish-golden colour of the pigment itself.

Case 2.

Emma J., age 27, mill-hand, came to the Leeds Public Dispensary complaining of a large swelling on the front of the left wrist. Two and a half years before, she had fallen and injured the wrist, which swelled and became discoloured. A short time afterwards a small tumour made its appearance on the flexor aspect of the joint, and gradually increased in size. It was almost continuously painful,

and from time to time the skin covering it became markedly discoloured, possibly as a result of trauma. She eventually sought medical advice on account of the pain, by which time the tumour had increased to the size of a walnut.

The tumour was removed by Mr. Douglas Seaton at the Leeds Public Dispensary in October, 1911.

There was no recurrence, and at the present time (January, 1915), the patient is in good health, with a sound and useful hand. There is an inconspicuous scar on the flexor aspect of the wrist extending on to the hypothenar eminence, but there is no tumour, and the movements of the joint are not interfered with. Mr. Seaton does not remember if the growth was in any way related to the flexor tendons or their sheaths, but from its position it must have been in very close proximity to them, as well as to the annular ligament of the wrist.

FIG. 36.—*Case* 2. SECTION OF TUMOUR, FROM PERIPHERAL PORTION OF THE GROWTH, showing groups of xanthoma or foamy cells. There are no giant cells in this field. (× 250). (*Figs.* 34, 35, *and* 36 *are from drawings by Miss Ethel Wright.*)

Histology.—This tumour bears a close resemblance to the first case, with one notable exception. Here there are present, in addition to the other constituents, a very considerable number of foamy cells, the 'lipoid' or 'xanthoma' cells of authors (*Fig.* 36).

The tumour is fibrocellular in structure. It is composed of oval, spindle, and spheroidal cells, which tend to form groups and even actual alveoli, with strands of fibrous tissue of varying width running between. Scattered with considerable uniformity throughout the section are a number of typical 'myeloid' giant cells, with multiple, small, deeply-stained nuclei, and, in most cases, strongly eosinophilic cytoplasm. Not a few of them are intra-alveolar in situation, in close association with groups of the small tumour-

cells. The xanthoma or lipoid cells are situated only in the peripheral portions of the growth, and not at all in the central area. They occur singly, but more often in little groups, and on account of their clearness and lack of cytoplasmic staining, constitute a very striking feature of the section. These cells are possessed of a very well-marked limiting membrane, and a relatively small, deeply-stained nucleus, while the cytoplasm is so finely reticulated and so faintly stained as to be almost invisible. Only once have we found giant cells in immediate relation to these groups of lipoid cells. In this particular instance, however, one of the two giant cells concerned has foamy cytoplasm similar to that of the surrounding xanthoma cells, while the other has the usual deeply-stained cell body.

The growth is surrounded by a thin but dense fibrous capsule.

As we could only obtain one hæmalum-and-eosin-stained section of this tumour, from which the above description is written, we have been unable to study the characters in any greater detail. It is especially unfortunate that no material was available for the study of the lipoids, but doubtless the foamy cells had the usual content of cholesterin and other fatty substances.

COMMENTARY.

Clinical.—The two cases here recorded are of considerable clinical interest. In respect of their long history, the early age (27) at which they occurred, and their clinical characters generally, they may be regarded as typical examples of their class. It is of especial interest that in both there is a definite history of local injury: in *Case* 1 an incised wound of considerable extent occurring some two years previously; and in *Case* 2 severe bruising some months before the appearance of the tumour. In Tourneux's series, a history of trauma was obtained in only a few of the cases. In Grant and Stewart's case there was a history of a stab by a knitting-needle five months before the appearance of the growth, and a similar history was given in one of Fleissig's cases. Of the four cases (unpublished) referred to by Shaw Dunn, in one only was there a history of injury.

With regard to the diagnosis, stress is to be laid on the small size of the tumour, and on the very slow rate of growth. Pain is usually absent, and, unless the growth attains to a considerable size, function is but little interfered with. It is not adherent to the bone, and the skin may move freely over it or be slightly adherent. The diagnosis can only be made with certainty by means of the microscope; but a very probable clinical diagnosis can usually be arrived at beforehand.

As these tumours are, to all intents and purposes, benign growths, conservative treatment should be adopted. The tumour should be excised locally; it can usually be shelled out with considerable ease; and in the event of recurrence, we think that a second local operation should be given a trial before anything radical is done.

On removal, the growth is characterized by its great density, its frequent lobulation, and peculiar greyish-yellow colour on section.

The precise site of origin of these tumours is not always perfectly clear.

The great majority undoubtedly arise from tendon sheaths, but a certain number apparently take origin from fascias, such as the palmar fascia. Both these varieties are included in the accompanying bibliography, which we believe to be complete.

Pathological.—The chief interest centres in the true nature of these growths. Are they true tumours, or are they granulomas ? Related to this is the further question of the nature of the giant cells. As to the two cases here described, we are strongly of the opinion that they are true tumours. The minute structure is, as we have stated, that of an endothelioma, and has nowhere the appearance of granulation tissue. Furthermore, there is a complete absence of any of the ordinary inflammatory cells within the tumour, and in both the growth is sharply defined, lobulated, and encapsuled, in a way that is rarely if ever seen in the case of inflammatory formations. The occasional presence of xanthoma or foamy cells within these tumours, as in *Case* 2, has had, we believe, too much significance attached to it, and the same is true of the occasional occurrence of extracellular deposits of crystalline cholesterin. It has been shown by one of us[41] that these phenomena are met with not infrequently in a large variety of pathological conditions, including not a few new growths of various sorts, and that they are dependent on the retention in the tissues of crystalline cholesterin and cholesterin esters, resulting usually from tissue disintegration. When the amount of cholesterin liberated in this way is small, it is entirely contained within phagocytic (? endothelial) cells, forming the so-called foamy, xanthoma, or lipoid cells, probably in a fluid crystalline state. When the amount liberated is greater than these cells can cope with, it is deposited extracellularly, either as fluid crystals, or in acicular or tabular form, giving rise to a very characteristic appearance of chinks or clefts in paraffin sections. If the crystals are deposited in the midst of living tissue, they come to be surrounded by foreign-body giant cells, and the histological appearances then become even more striking.

Cholesterin in solution, or in a colloidal state, is, of course, a constant constituent of all living cells, but its presence under these conditions does not seem to be associated with any special microscopical appearances. Such cholesterin, moreover, is optically inactive, whereas crystalline cholesterin, which gives rise to the cellular reactions just described, is doubly refracting and consequently readily detected.

Cholesterin clefts with adjacent giant cells similar to those mentioned above are described and figured by Fleissig in one of his cases, and from this, as well as from the presence of foamy cells, he concludes that cholesterin may have an important etiological significance in these growths. The same view is expressed by Spiess, who found xanthoma cells in all four of his cases. Shaw Dunn also refers to the presence of cholesterin, and states unequivocally that " the giant cells are related to the presence of the cholesterin."

We can readily believe that deposits of crystalline cholesterin may occur with considerable frequency in myeloid tumours of tendon sheaths, as in many other forms of new growth, and may even have foreign-body giant cells related to them ; but we cannot accept this explanation as applied to the giant cells of the tumour generally. In our second case, foamy cells were

present in considerable numbers, but were confined entirely to the more peripheral portions of the growth. In neither of our cases were cholesterin clefts discovered, although numerous sections were examined. In Fleissig's second case the cholesterin deposits were present only at the periphery of the growth, while the giant cells were more or less uniformly scattered throughout the tumour tissue, as is the invariable rule in these cases.

Conclusive evidence that cholesterin is not the etiological factor in the formation of the giant cells is afforded by our first case, in which the examination of frozen sections by the polarizing microscope showed that the tumour tissue proper was completely lacking in doubly refracting lipoid. When deposits of cholesterin, such as these authors describe, occur in these tumours, we believe that they are due to local and secondary tissue changes, and that they are of no etiological significance. The 'myeloid' giant cells we believe to be of tumour origin, and an essential part of the growth—partly on account of their uniform, non-focal distribution and their relation to the other tumour cells, partly because of the absence of any known foreign-body or other stimulant to their production.

The iron-containing pigment seen in *Case* 1 is in the main distributed throughout the loose fibrous tissue which binds the tumour lobules together. Here and there a few small foci are seen within the tumour tissue proper, but doubtless it is all derived from old local hæmorrhages, the result of the repeated traumata to which the growth must have been subjected in the course of its eight years' existence on the hand of a working man.

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CONTEMPORARY FRENCH SURGERY.

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French surgery in 1914 includes two distinct periods, differing from each other as peace from war. During the first seven months its evolution was normal. No great discovery in surgery was brought forward, either on the operative or scientific side; but this period was characterized more especially by the endeavour to perfect the study of each detail.

Our hospital service has been progressively improved by the addition of new sterilizing instruments and apparatus. Our laboratories, too, are better fitted up and worked. These, however, constitute but the natural progress which is common to the surgery of all nations.

French surgery is led by the Paris school, but a great deal of emulation is found in Lyons, where much remarkable work has been accomplished. Anyone, therefore, who wishes to be fully acquainted with French surgery, should read *Le Journal de Chirurgie*, *Les Bulletins et Mémoires de la Société de Chirurgie*, and *Le Journal de Chirurgie de Lyon*.

The employment of *ether* to produce general anæsthesia has made considerable strides and has become general. *Local anæsthesia* has again been discussed on the proposition of M. Reclus, and many surgeons acknowledge its utility, though not going so far as the author with regard to its generalization. A straightforward operation, and one which is at the same time clearly limited as to its field of action, is the ideal one for this method. It is principally the slowness of the anæsthesia and the slowness of the operation that limit the employment of this mode of anæsthesia with a large number of surgeons. Nevertheless, no formal conclusion has been arrived at since the death of M. Reclus put an end to this discussion at the *Société de Chirurgie*. Other procedures that have been recommended, based on *intravenous injections*, have not been adopted by French surgeons. On the other hand, we have some supporters of *lumbar anæsthesia*.

GENERAL SURGERY.

General operative technique has undergone no change: disinfection with iodine, and the use of *ether* in certain abdominal infections, were both known to us last year and are still employed by us (Morestin, Souligoux); some surgeons, however, have protested against these methods of antisepsis.

In the same way the treatment of extensive infection by specific or polyvalent *sera* has furnished no reliable results. The *transfusion of blood* has made no further progress; the paraffin cannula I brought forward, slightly bent into the form of an S, still remains the apparatus of choice.

Ovarian grafts have been the subject of a very complete study brought before the *Société de Chirurgie* and at the London congress by Tuffier. He has studied the operative technique, the immediate and remote clinical results, and microscopic specimens of grafted ovaries after from one to five years. He comes to the conclusion that this proceeding furnishes very good results when an autograft is employed; in the following six months regular menstruation is seen, with disappearance of all the phenomena of the anticipated menopause; the menses may persist regularly for several years. In some cases after two or three years the ovary atrophies. The vitality of the graft is demonstrated by microscopic examination, which shows the presence of corpora lutea.

Grafting of bones and of fatty tissues has continued without much noticeable progress. Morestin has, however, indicated the great value of the surgery of repair, of which he has brought forward many examples.

The question of *fractures* is still under discussion. Those who advocate open operation and suture have brought forward some interesting results. Two schools have been established: those who favour treatment by ambulatory or extension apparatus of the Hennequin type (Routier, Delbet, Souligoux); and the supporters of operative traction (Quénu), and of open operation and suture (Tuffier, Dujarier).

SURGERY OF THE HEART.

Surgery in the cardiac region is becoming more and more important and extensive. Urgent intervention in this region is showing an increasing number of successful operations. A communication from M. Veau[1] to the *Société de Chirurgie*, dealing with a revolver wound of the anterior aspect of the left ventricle, gave rise to an interesting discussion. Lecène[2] brought forward a case of the application of three non-perforating points of suture to a right ventricle which had been wounded by a revolver bullet. Aulong and Bondol[3] made a study of the remote results after the suture of a wound of the right auricle caused by a stab. The questions to decide are: what exactly were the lesions operated upon, and, would they necessarily have entailed death?

The pathological side of *cardiac medicine* is being invaded by surgery every day. Delorme[4] lays down as a principle that the only two clinical pathognomonic signs of mediastinopericarditis are the fixity of the apex and the invariability of the cardiac dullness. Further signs are afforded by radioscopy; immobility of the margins and of the apex, and constancy of the radioscopic form of the heart during respiratory movements. Gardère and Ainaud,[5] Weil, Leriche and Mouriquand,[6] bring forward the results of their experiments. Giquet[7] plainly lays down the conditions which contra-indicate intervention—namely, when the mediastinopericarditis is accompanied by valvular lesions. Operation is especially indicated in the case of a tuberculous lesion, for under these circumstances it yields the best results. Pericardial thoracotomy should be carried out from the 3rd to the 7th costal cartilage.

I have brought forward the experimental results gathered at the

Rockefeller Institute, New York, with Carrel, on *valvulotomy* of the pulmonary and aortic orifices, as well as my own first attempts on the human subject (*Acadèmie de Médecine.*)

VASCULAR SURGERY.

Vascular surgery, which until the last few years has been solely in the hands of the leaders of experimental science, shows at present a tendency to become common property. Moure[8] sets forth the technique and the experimental results of veno-arterial grafts, where the small venous graft does not play the part of a simple conductor, but has a vitality of its own, as proved both by the permeability of a piece of the jugular made to take the place of 2 to 5 cm. of a dog's carotid, and removed after twenty-six months, and also by histological specimens in which one may see the hypertrophy of the middle elastic coat after temporary disintegration.

Vascular *suture* is employed in the human subject after traumatism. Sencert[9] sutured with two non-perforating silk whip-stitches the common femoral artery of a patient who had been wounded by a steel splinter at the level of the middle third of Scarpa's triangle. The popliteal, the anterior tibial, and the dorsalis pedis arteries showed arterial pulsation a year after operation. Billet[10] sutured a femoral vein which had been opened for the length of a centimetre by a knife, and the patient was able to walk sixteen days afterwards without exhibiting a trace of œdema.

In these results there is a lack of definite evidence, leaving one in some doubt as to *the lasting permeability* of the vessel. One cannot lay undue stress on this theoretical point of view, for in practice the progressive obliteration of an artery after suturing certainly does not present the disadvantages of an immediate total ligature.

SURGERY OF THE DIGESTIVE TRACT.

The surgery of the digestive tract is still a favourite subject with many writers, and the power to arrive at an *early diagnosis of gastric cancer* becomes every day more necessary. Simon and Caussade[11] propose making a cytodiagnosis by a very simple method. They give the patient 250 grams of saline solution, and then gently knead his stomach. The final centrifugation of this liquid allows histological examination of the cells it has brought away, and also of the small clots that have carried with them fragments of the tumour. By means of this direct method, the seat of the commencement of the growth can be diagnosed.

The study of *gastric ulcer* has given rise to important results. Its diagnosis from duodenal ulcer is the subject of a thesis.[12] Pains in the right hypochondrium, frequent intestinal hæmorrhages, an absence of gastric symptoms, and the rapid onward transmission of chyme, accompany the duodenal variety of ulcer. Petit[13] has called attention to the existence of *traumatic ulcer.* He has studied its pathogeny; and has shown that its evolution is less severe than that of Cruvelhier's ulcer. But most of the work done deals more especially with the therapeutics of the ulcer

and its hæmorrhagic and constricting complications, whether mediogastric or pyloric.

Rostreur[14] formally lays down the *operative indications* of the hæmorrhagic forms of ulcer; he is opposed to operation in fulminating hæmorrhage, but advises it in acute or chronic hæmorrhage—excision or resection if the lesion is very isolated; otherwise gastro-enterostomy, especially if there is a tendency to stenosis.

The value of *pyloric exclusion* when compared with gastro-enterostomy in these pyloric or paraduodenal ulcers, is studied by Enriquez and Gosset;[15] at the same time the Lyons school (Delore and Sauty)[16] extol gastrectomy, which, according to them, is the only way of avoiding hæmorrhage. This, too, is the operation utilized by Hartmann[17] in sclerohypertrophic lesions of the pylorus, similar in the adult to the hypertrophic stenosis of infancy.

Medio-gastric stenosis (*hour-glass stomach*) is fully studied by Leuret,[18] and P. Duval[19] upholds gastrectomy on every occasion when adhesions do not render a resection impossible. Otherwise this surgeon advises a gastro-gastrostomy when the pyloric pocket is large and the cardiac pocket small, a gastro-enterostomy when the pyloric pocket is small, a gastro-gastrostomy and a gastro-enterostomy when pyloric stenosis complicates a bilocular stomach. These conclusions were formulated and supported by Tuffier.

Stasis of the colon shows essentially different symptoms according to its situation on the right or left side (Sorel[20]). In a communication before the *Société de Chirurgie* by Pierre Duval and J. C. Roux,[21] reference is made to this subject, Lenormant, Mauclaire, Delbet, Cuneo, Lambret taking part in the discussion that followed. The authors regard membranous pericolitis, movable cæcum, atonic typhlectasis, chronic cæcotyphlitis, as causes of this stasis. They advocate excision of the ascending colon in membranous pericolitis showing grave symptoms, and in chronic typhlitis with parietal deterioration and enlarged glands in the vicinity of the colon. They declare that the freeing of adhesions is insufficient. Jackson's membrane, after having been incriminated for a long time, is now proved to have a congenital origin. Cæcoplasty is only indicated if there is an enlarged cæcum without subhepatic bands and no chronic typhlitis. These studies are a reflection of English and American work.

Cæcosigmoidostomy, with or without excision of the colon, but following the new method recommended by Lardennois,[22] who first frees the large omentum from the transverse mesocolon to allow of separate ligature of the colic vessels and easy division of the ligaments of the flexures while retaining the large omentum, will be reserved for those cases in which permanent drainage is absolutely necessary, whether the case be one of atonic hyperectasis, of chronic cæcotyphlitis, or kinking of the splenic flexure with lengthening of the pelvic colon. Duval and J. C. Roux[23] show, with the help of radiography after an enema or an injection of bismuth emulsion, that simple cæcosigmoidostomy has the great advantage of not suppressing the functions of the colon, but that its sole object is to relieve them.

P. Cruet[24] discusses the best operative technique applicable to the method of delivering the growth in the extirpation of *cancer of the colon*.

The question of dealing with extirpation of cancer of the colon is in itself of the greatest importance. In cases of cancer of the left flexure which is infiltrating, very septic, and has invaded the suprajacent coil of intestine, Cruet proposes bringing out the tumour through the parietes, and dealing extra-peritoneally with the vasculonervous pedicle. The operation should be performed in three stages: the cancerous coil is first brought out, its mesentery spread out, the fold of peritoneum covering one of its sides incised and separated as far as possible from the suspected zone. Suture of each portion of the mesentery to the parietal peritoneum, and isolation by means of compresses of the coil brought out of the peritoneum are carried out. The abdominal wall is closed with catgut.

The second operation is undertaken in about eight days; the coil is excised and an anastomosis made between the posterior halves of the two ends of the intestine, the two anterior halves being attached to the skin. At the third operation the artificial anus is closed by enterorrhaphy. This is only undertaken after a considerable interval, when the general condition of the patient has improved.

SURGERY OF THE NERVES.

Pierre Marie has proposed to practise *decompression* of the healthy hemisphere in certain cases of cerebral hæmorrhage before there is any rise of temperature; it is purely a decompressive operation, the dura mater being respected.

Operations on the *nerves of the salivary glands* have succeeded in the hands of Leriche;[25] for fistulæ, particularly of Steno's duct, and for certain cases of aerophagy caused by hypersalivation, he advises bilateral section of the lingual nerve with tearing away of the auriculotemporal nerve in the one case, and simple section of the auriculotemporal nerve in another.

Excision of nerves performed by D. Zwirn and L. Hayem[26] arrested the development of a bilateral senile gangrene accompanied by very violent phenomena; resection of three or four centimetres of the posterior tibial and musculo-cutaneous nerves brought about repression of the gangrene, with re-establishment of the circulation. These excisions, carried out as close as possible to the lesion, take away pain, and from being merely palliative become curative when, as in many cases, the gangrene is due to a prolonged spasm of the vessels of any particular region.

The treatment of *Little's disease* has been discussed, and important reservations have been made with reference to the operation of rhizotomy in its different varieties (Foerster, Guleke, Van Guchten). Broca and Mauclaire think that orthopædic treatment should suffice.

UROLOGY.

Suprarenal Tumours.—M. Tuffier has studied cases of suprarenal virility, a curious affection characterized by rapid growth of the child with virile development, or by a masculine appearance if the patient is a female, all this being due to a hypertrophy or a benign tumour of the suprarenal bodies. He showed a very interesting example.

New procedures, physical and biological, as well as surgical, are applied to urology.

Legueu and Morel[27] show that by means of hæmatic examination early diagnosis of *cancer of the prostate* can be made from adenoma, for in the latter the tumour is accompanied by a suburethral eosinophile infiltration with 5 per cent eosinophilia, while cancer exhibits a blood picture of polynuclear leucocytosis with hypo-eosinophilia.

High-frequency currents were applied by Heitz-Boyer[28] as a therapeutic adjuvant, either to hasten the cicatrization of tuberculous vesical ulcerations persisting after nephrectomy, or to obtain a more radical cure of vesical tumours; a fortnight after the extirpation of the latter, high-frequency currents applied through the endoscope complete the destruction of the pedicle.

Regional anæsthesia was systematically used by Sourdat[29] in nephrectomy. Pure solution of novocain, 1–200, is sufficient for the whole operation. Cutaneous anæsthesia, at first, according to Reclus's method, in a line over the spinous processes from the 7th dorsal to the 4th lumbar, enables the nerves to be infiltrated by carrying the needle either to the origins of the ribs or to the level of the roots of the transverse processes. Nephrectomy can be performed after infiltration of the last five intercostal nerves and the first three or four lumbar nerves.

A new treatment, by hypogastric gangliostomy, of some rebellious forms of *cystalgia* during old cases of cystitis seems to have produced happy results in the hands of Rochet and Letarjet,[30] who have studied its various phases.

Francey[31] studies the advantages of operation by the transvesical route for *vesico-vaginal fistulæ* whenever the fistula cannot very easily be brought down, either owing to its high situation, or because the vagina is sclerosed and narrowed. This technique, which has the advantage of giving a full view of the fistula, allows the surgeon, by hypogastric drainage, to afford absolute rest to the bladder. The method, however, is but rarely indicated.

Gerard, of Lille, has made an interesting study in the *Journal d'Urologie* of wounds of the bladder by impalement. He has demonstrated the varying gravity of these cases. When there are intraperitoneal lesions, laparotomy is indicated; but, on the contrary, abstention should be practised in extraperitoneal wounds.

GYNÆCOLOGY.

In *puerperal infection*, Proust and Maurer[32] have laid down the technique of ligature of the internal iliac veins.

With reference to *cancer of the uterus*, Chéron, Rubens and Duval have reported in *Les Archives le Gynécologie* 158 cases treated in five years. They only had one absolutely certain cure, and 93 recurrences. Treatment of uterine cancer by radium and *x* rays has been studied, and in inoperable cases radium has seemed to be the best palliative treatment (Beclère).

Under the name of *peri-metro-rectal fibrosis*, J. Fiole, of Marseilles, has studied an inflammatory disease consisting in strangulation of the rectum by fibrous masses, the remains of old perfectly-cured lesions of the uterus and of

the appendages. As treatment they propose thermal springs, massage, vaginal division of the bands, and even in some cases hysterectomy.

Myomectomy, a proceeding which I have upheld for many years, has found an ardent advocate in my colleague Goullioud, who brought before the *Société de Médecine* of Lyons 74 myomectomies, with 5 subsequent pregnancies; he employed the technique which I have indicated.

Pozzi has described a method of *perineorrhaphy*, in cases of complete rupture of the perineum, by mobilization of the rectum, an analogous operation to the one for rectovaginal fistula.

I have already referred to ovarian grafts.

WAR SURGERY.

During the last five months the attention of all French surgeons has naturally been drawn to war surgery.

The following are the chief points learnt as the result of our experience with the army: The *grave infection* of nearly all wounds received in warfare, and the absolute necessity of *rapidly transporting the wounded* to a well-equipped hospital, for which purpose numerous motors are absolutely indispensable. As regards the wounds themselves, *the earliest possible extraction of foreign bodies*, especially those from artillery fire; Chassaignac's *drainage*; perfect *immobilization* of bones and of articulations, and the *quickest possible disinfection of the wounds* are my suggestions for treatment at 'the front.' The great importance of all these points is incontestable.

With regard to the question of antiseptics, there exists a difference of opinion; every surgeon extols his own method. The usual antiseptics have gone bankrupt; new ones must be found with a more permanent action. Researches in this direction of the highest importance and necessity are being made. For myself, I entirely share the opinion of Wright and Watson Cheyne. In all cases, however, we must rely more on light, good air, and on the free evacuation of discharges, rather than on any special antiseptic, except perhaps hypochlorite of magnesia.

The same may be said with regard to *serotherapy*. No polyvalent serum, no specific serum, can make the patient safe from infection. Only the preventive *antitetanic injection* is of use. Personally, I have seen but one case of tetanus in six months; this period is coincident with two important changes in the Medical Service: on the one hand, injections of the sera; on the other, the immensely greater rapidity of the attention given to the wounded.

After tetanus, the most serious infection is *gas* or *emphysematous gangrene*. From the very beginning of the war, having seen numerous cases at the front, I urged the necessity of dividing up this so-called morbid entity into forms which, from the point of view of therapeutics and of prognosis, are absolutely different. A localized wound may be accompanied by a swelling which constitutes a veritable gaseous phlegmon, but which disappears when simple incisions are made to relieve constriction (Tuffier, Quénu, Pauchet, Ombredanne, Depage, Lapointe). In the same way, gangrene complicated by gas may occur in certain vascular lesions. This is not gaseous septicæmia, which is character-

ized by a special tinge of the limb, and especially by the extreme rapidity of its development. It comprises two varieties: one, acute, in which it has been proposed to relieve the tension with the actual cautery; with Michaud, I have proposed the application of a cautery with points at intervals of a few centimetres; other surgeons have advocated amputation. Here again, a cure is possible. Depage, of Brussels, has given us an interesting method of treatment: he injects oxygen above the limit of the gangrene. The most important fact is that in all the cases I was able to see at La Panne, it was a question of a *superficial* gaseous gangrene and not of deep gangrene. Morestin has proposed formol in these cases. In fact, the infection is still curable. The second variety is hyperacute gangrene, which in twenty-four hours has extended past the limit of the root of the limb, and which is always fatal.

I should here like to point out for the first time, that I have not seen in any of the field stations or hospitals, either at the front or the rear, a single case of gas gangrene following a wound of the skull, the face, the neck, or even of the supraclavicular region or of the chest. The lower limb is much more often affected than the upper.

The bacteriology of the affection has been much studied. The *Bacillus perfringens* and a septic vibrio appear to be the inciting agents of this septicæmia; this, however, must be accepted with some reserve, for the above microbes are nearly always associated with other infective agents. What is absolutely certain is that wounds from the bursting of a shell, and more especially those wounds that contain foreign bodies carried in from the clothes, are nearly always the origin of the affection.

The therapeutics of gas gangrene are still being studied. The best treatment is the immediate disinfection of the wound. Depage recommends injections of oxygen into the gangrene itself and above it; he makes subcutaneous injections into the tissues. Ombredanne prefers the freeing of all bands with the actual cautery. Delorme has recommended peroxide of hydrogen, which does not appear to have given much result. It seems at the present time that, in general, French surgeons propose simple incisions to relieve tension; drainage, lavage, and cauterization of the wound. When it is a question of a gaseous phlegmon, free incisions should be employed; when there is ascending gangrene, injections of oxygen are called for, or punctiform cauterization such as Labbe formerly carried out, and from which I also have obtained good results. Finally there is amputation, but generally this is unavailing. No success has been reported from the use of anti-gangrene serum. The most important point in this condition is to carefully consider the clinical forms; by this alone can we attain real therapeutic knowledge. Statistics taken *en bloc* have therefore no value at all.

As a general factor, *shock* occupies a particularly remarkable position. Morestin has done well to speak of algostasis, and for my own part, amongst hundreds of cases, I have been able to verify many times the effect of a subcutaneous injection of morphine given to a wounded man, especially when he has to be transported for some considerable distance.

As to the *general therapeutic measures* in the French army, we admit, and

the members of the *Société de Chirurgie* are of the same opinion, that no wound received in warfare, and treated in the hospitals at the front, should be sutured. Very grave accidents have followed the application of simple suture-clips to a wound whose edges seemed fairly clean. It is necessary to start from the assumption that all these wounds are *infected.* If this were an actual fact, then incisions to relieve tension, and drainage, would seem to be absolutely indicated in all cases. This, however, is an exaggerated view. Some perforating wounds from rifle bullets and even from shrapnel are capable of healing under the first dressing; even wounds of joints and of bone may heal in the same way. The following is the plan we employ at the present time: application of an aseptic dressing to the two orifices of the wound if the limb is in a sound condition; but if it be swollen, incisions are made at both orifices to relieve tension, and drainage applied.

Side by side with infection I place the effects of *frost-bite* or freezing; they have been the subject of very numerous military reports that have not been published, and of communications to the *Société de Chirurgie* (Hartmann, Bressol, Desgouttes, Tuffier). Two facts are here considered. First, the effects of congelation due to excessive cold, which here as elsewhere are often complicated by gangrene, infection, and subsequent neuritis; second, an affection, already noticed in Manchuria, which has given rise to keen discussion, and which I have called *the trench disease.* It presents the effects of frost-bite without, however, the existence of a very low temperature and without the presence of snow or ice. I have studied this affection principally in the north and in the Argonne, where I have seen hundreds of examples. These were always soldiers who had remained for several days in the trenches without being relieved, standing in a liquid mud which was half-way up their legs. The affection began with painful œdema, followed by phlyctenulæ in the second stage; in the third stage there was sphacelus of the skin of the toes at the extremity of their plantar aspect; finally, gangrene of the whole of the front part of the foot supervened. Damp is the cause of these symptoms, aided perhaps by a tight boot. Slight forms get well in a few weeks; grave forms end in amputation, of which unfortunately we have a good many examples. Our black troops were particularly predisposed to this malady, also those of our soldiers who remained for too long a time in the trenches without being relieved. On the other hand, I have not seen it either in cavalry soldiers, in sentinels, or even in gunners; it is therefore a special affection of the trenches. Alglave has even mentioned cases in which tetanus followed these effects of frost-bite. The treatment is essentially prophylactic: loosening the boots, active motion, and, above all, better hygiene of the trenches. These precautions are sufficient to cause disappearance of the affection.

The Vascular System.—*Traumatisms of the vessels* are extremely frequent. They appear under two forms: secondary hæmorrhage and aneurysm. I pass over primary hæmorrhage, which all our surgeons at the front arrest by ligature. The tourniquet is sometimes utilized under circumstances where it is actually impossible to apply a ligature, but it has caused disasters. As soon as a tourniquet is seen in an ambulance it should be taken away.

Secondary hæmorrhage has been studied by Quénu, Tuffier, and Thierry; it supervenes under two conditions: in some cases by the giving way of the clot or the scab; in others by the displacement of a splinter. In all the cases we have come to the following conclusions: if the focus is aseptic and easily got at, ligature at both ends of the wound; if the focus is reached with difficulty, or if the wound is gangrenous or infected, it is better to tie the artery above the seat of the hæmorrhage in a healthy part. It is a curious fact that I have seen hæmorrhage from the axillary, the subclavian, and the femoral arteries; but having tied them, I have never observed gangrene to set in.

It is quite a different thing with *aneurysm*. Picqué, Menil, Pierre Duval, Quénu, and I myself, have brought forward numerous examples. Here it is always a question of an interstitial hæmorrhage, pulsatile, nearly always consecutive to the passage of a bullet, the two cutaneous orifices caused by which have rapidly healed up. Here, again, opening up the focus, and ligature of the two ends of the vessel, are indicated; but gangrene of the lower limb in these cases is frequently observed, contrary to what we have noticed in arterial wounds; I have seen it myself.

Capillary hæmorrhage may generally be ascribed to granulations having been scratched.

Wounds of the heart are nearly always mortal on the battlefield; the middle of the sternum is very often the wounded region in such cases. A very curious fact is reported by Dr. Fromont: when a prisoner in Germany, he had next to him a Frenchman, also a prisoner, who had an unmistakable wound of the heart which had healed up spontaneously, leaving a grave lesion of the mitral valve. I do not know of any instance of primary suture of a wound of the heart.

The Nervous System has been the object of numerous researches, as it has been the seat of numerous lesions.

Wounds of the Skull.—Auvray, Chavannaz, Rouvillois, Pauchet, and Broca, all recommend immediate trephining going beyond the limits of the fracture, with removal of the splinters. The practice of opening the skull every time the scalp has been touched seems an exaggerated precaution; but in truth it must be remembered that an insignificant traumatism of the skull may become complicated by a cerebral lesion, and at the front I have seen a considerable number of wounded men who had returned on foot more than four kilometres from the place where they had been wounded, and who had a projectile within the skull. The prognosis in these cases has always seemed to me the more serious the further one gets from the front; for if the immediate results are good, the late results seem, up to the present, deplorable; and the directors of the French Medical Service recommend, in the zone of army operations, the absolute immobility of these wounded men, and their prolonged stay in the field hospitals.

Wounds of the Spinal Cord may be divided into two categories: complete section, which has always been fatal, and the higher its seat the more rapid the fatal effect; and incomplete or radicular wounds, which seem to have nearly all healed. The proportion of cases of compression is very small, and these

are the only lesions that necessitate laminectomy; surgeons are unanimous on this point. The nerve plexuses are often attacked at the level of the supra-clavicular region, and the brachial plexus is often affected. Suture in this situation, as in others, can be carried out; but experience has shown me that it ought to be done at once, for there is no case recorded where suture has even produced improvement.

With regard to *Peripheral Nerves*, Delorme has brought before the *Académie* an account of more than 80 cases on which he had practised resection of nerve segments. As a whole, the French surgeons have declared against this method. We recommend the following plan in all cases of section of nerves: (1) Carry out a most careful examination to ascertain if there is merely compression (which is very frequent), or complete section of the nerve; (2) During the operation, carry out a similar examination by exciting directly the superior end of the nerve in order to ascertain if the current acts on the innervated muscles. This would be a proof that the section, if complete, is spontaneously sutured, and that the divided part must not be touched except to free it from its adhesions; (3) If there is section, with separation of the two ends, suturing with Carrel's thread seems to me the best course to pursue. Finally, (4) Between the two nervous extremities we find a large fibrous part that is not traversed by the current; in these cases resection and suture are indicated.

By far the most interesting fact connected with this subject is the extreme frequency of paralysis arising from the simple enveloping of a nerve in fibrous tissue or in osseous callus. Simply freeing and isolating it in healthy muscle are sufficient for rapid cure. As to the late results of nerve suture—that is, with subsequent recovery of movement—they have not yet been brought before our Societies.

Foreign Bodies are often difficult to locate; for this purpose we have apparatus made on the model of Contremoulins—that is to say, furnished with a directing needle which allows the surgeon during the operation to search for the situation of the foreign body, and provide him with a guide (Marion, Harret, Mauclaire, Heitz). Lastly, Bergonié, of Bordeaux, has constructed a vibrator which, placed in the region where the foreign body is supposed to be, indicates its situation by the intensity of the vibrations imprinted on the skin. The apparatus is rather puzzling, and its application somewhat painful.

Fractures of the Maxillary Bones and **Wounds of the Face** are dealt with by Sébileau, Boisselin, and Tuffier. Maxillary wounds are treated with great care by dentists, who, from the very beginning, apply to the fragments, or fashion—when necessary to replace them—bridges which render very great service.

Wounds of the Chest brought to the ambulance are not always of the small importance often ascribed to them (Kendirdjy, Dufourmentel, Tuffier). Hæmothorax is absorbed very slowly; it is accompanied by prolonged febrile symptoms, and necessitates puncture when it gives rise to dyspnœa; but one

must not be in a hurry to open a hæmothorax; for it may undergo spontaneous cure, even after several months. Let me draw attention to one common fact; the fluids may be of a red colour without signs of secondary hæmorrhage, and this even after several consecutive punctures. In fact, this red liquid is not blood; for I have shown that it does not coagulate in a vessel in which it has remained for twenty-four hours. Empyema, generally due to the presence of a foreign body, or else to wounds caused by the bursting of a shell, is treated by early thoracotomy, and generally gets well if the conditions are favourable.

Wounds of the Abdomen.—Dupont, Kendirdjy, Sancert, Tuffier, Quénu, Marcille, Gosset, and Hallopeau, have dealt with this question. The following definite conclusion has been reached: Some wounds of the abdomen heal spontaneously even with a stercoraceous fistula, and generally they are lesions of the large intestine. Hæmoperitoneum heals after incision or laparotomy, but more often spontaneously.

As regards laparotomy for a wound of the small intestine, with suture, resulting in cure, I do not think (from enquiries I have made at the front) that there exist at the present time twenty such cases in the French army. These failures depend on the multiplicity and the gravity of these wounds, on the condition of the patients, and on the precarious state of the resources for immediate operation at the front. For this reason automobiles have been attached to the surgical ambulances; later on we shall be in a position to appreciate their utility. Wounds of the liver and of the spleen are complicated by hæmoperitoneum which may recover. Wounds of the gall-bladder are followed by fistula, which is spontaneously curable.

Wounds of the Bones and Joints.—The great surgical question at the present time is that dealing with wounds of the limbs complicated by fractures and wounds of the joints. To-day an articular wound without reaction is just simply dressed. If there is a loose fragment, *arthrotomy* becomes necessary, especially in the knee or the elbow. *Transarticular drainage* is the general rule. Carrel has substituted for this a puncture of the joint, with continuous aspirations, and has obtained good results; but if there is suppuration within the joint, ankylosis is the regular result. If the symptoms do not yield to treatment, I have advised excision. A great many of those who have undergone amputation have not had other wounds than these, for out of 260 cases which I have been able to find, about 60 had been wounded by a projectile on a level with the knee.

As a general rule, all traumatisms resulting from fractures of the lower limb are infinitely more serious and take longer to get well than those of the upper limb. Drainage, immobilization, and reduction are our three principles. Incisions to relieve tension in fractures of the femur, the careful removal of all splinters which are absolutely free, and drainage, constitute the method of choice. Immobilization in a plaster apparatus with a bend has still a large number of advocates (Couteaud, Quénu, Sencert, Prat, Tuffier). Lastly, continuous extension to obtain reduction has been applied by means of Hennequin's and other apparatus, but this is the least important

desideratum. As a matter of fact, the conservative treatment of wounded limbs is often limited only by the skill and patience of the surgeon. Infection constitutes the gravest danger, and much progress has been made in combating it.

All these problems, however, are still being investigated, and I think that next year it will be possible to offer much more precise conclusions. In the meantime, very briefly and very incompletely, such are the general outlines of the methods of French Surgery in the present war.

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NAVAL AND MILITARY SURGERY.

ILLUSTRATIONS OF WAR SURGERY.

[Under this heading we propose to publish during the war a series of drawings illustrative of military surgery in its various aspects. The BRITISH JOURNAL OF SURGERY is indebted to Col. Sir George H. Makins for his help in the selection of cases and for his clinical remarks on certain of those selected. The notes, supplied by various officers of the Royal Army Medical Corps under great pressure of work, are necessarily brief. The drawings have been made by Mr. A. K. Maxwell.]

Injuries to the Face inflicted by the Bursting of a Hand Grenade. (From No. 11 General Hospital, Boulogne. Under the care of Mr. H. F. WOLFENDON.)

THE drawing (*Fig.* 37) represents the condition of the head as seen upon the third day after the infliction of the wounds.

The latter were suppurating, and situated upon a base of a bright red colour involving the whole face and part of the neck. Vesication had exposed the papillæ of the skin over a considerable area, while the deeper wounds were clothed with dry black sloughs. The whole face was œdematous, and the eyes were closed by the swollen lids. The charring of the hair around the injured pinna illustrates well the part directly taken by heat in the production of such injuries. We have in fact contused and lacerated wounds accompanying a burn extending to the third degree.

The patient was transferred to England on the seventh day after the receipt of the injury, the wounds having meanwhile assumed a healthy granulating condition.—[G. H. M.]

Multiple Superficial Wounds produced by the Bursting of a Trench Bomb. (From No. 12 General Hospital, Boulogne. Under the care of Mr. ANTHONY BRADFORD.)

The drawing (*Fig.* 38) illustrates the condition as observed on the eighth day after the reception of the injury. The varying degrees of such lesions are well shown. The smallest wounds appear as mere concave discolorations of the skin, others as small deep circular pits or as linear gutters still occupied by the dark scab coloured by the blood-clot. The larger wounds, from which the fragments of bombs, clothing, etc., have been removed, are now granulating, and exhibit the well-marked indurated and everted edges which suggest such a striking resemblance to an epitheliomatous ulcer.

The patient, who was under the care of Mr. Anthony Bradford, was sent

home to England on the fifteenth day, with the wounds in a healthy granulating condition.

It will be observed that the whole of the missiles producing these wounds had traversed the patient's clothing. Such wounds are sometimes distributed over nearly the whole body of a man, and are produced not only by fragments of the bomb-case and its contents of miscellaneous scraps of metal, but also by stones and soil from the ground upon which the bomb alights and bursts.

FIG. 37.—INJURIES CAUSED BY A BOMB EXPLOSION.

The metal fragments may carry in shreds of clothing with them, besides which both stones and soil may be lodged in the tissues.

The wounds vary greatly in depth and severity; amongst a host of superficial injuries, one larger fragment of metal may have fractured a bone, penetrated a joint, or entered one of the great body-cavities. Naturally the uncovered portions of the body especially suffer, and the eyes are particularly liable to be damaged. The patient suffers from severe initial 'burning pain,' which persists for some hours only, and there may be more or less severe shock, due not only to the local lesions, but also to 'shell concussion.'

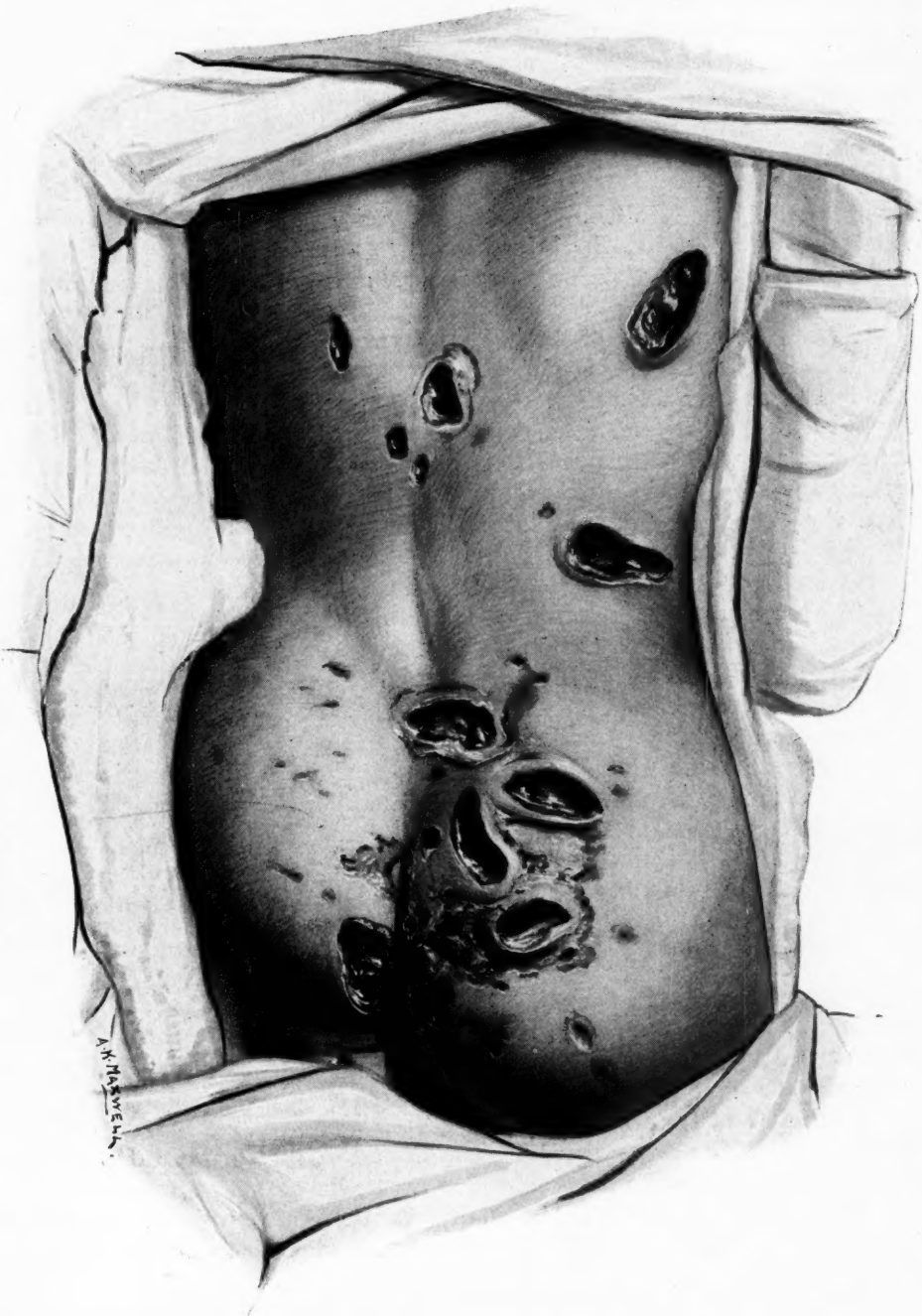

FIG. 38.—MULTIPLE WOUNDS CAUSED BY BOMB EXPLOSION.

When the patient is seen shortly after the infliction of the injury, the appearance is that of numerous areas of blackened skin of irregular outline, suggesting that pieces of black metal have been inlaid. The black surfaces are concave, while the surrounding skin retains its normal appearance. A patch of small areas gives the appearance of a coarse 'tattoo.' The surrounding skin rapidly becomes œdematous and swollen, especially where loose areolar tissue is abundant. In the eyelids, for example, the swelling may suffice to close the eyes in a very few minutes; later, a sticky discharge from the conjunctiva, the production of which is often no doubt furthered by the entry of dirt within the lids, suffices to glue the latter more or less firmly together. When the injury involves both scalp and face, the œdema gives rise to a very striking appearance; the whole face and head are enlarged.

From the margins of the black areas a bright red areola gradually extends, and in the course of a couple of days suppuration supervenes, and will loosen such small fragments of metal, etc., as have not been removed. At the end of this period the larger wounds look dirty and ragged, and are often infected with anaerobic organisms, which develop beneath the scab which tends to form. In the shallow wounds such infections do little harm; but from the deeper tracks, especially if a foreign body is retained, a gaseous cellulitis may extend widely through a limb and cause most serious trouble if unchecked.

The slighter wounds involving the skin alone, when circular, present on the third day or later a striking resemblance to a waning chicken-pox pustule, a small sub-epidermal ring of suppuration surrounding a dark spot or central pit. Again, when recently healed, the areas of discoloration of the skin resemble those seen after the healing of small-pox pustules.

Very similar injuries are produced by small fragments of high-velocity shells, and it may be difficult to determine which form of projectile has been responsible for their infliction.—[G. H. M.]

General Septic Poisoning in a Man suffering with 'Gas-gangrene' of the Arm. (From No. 13 Stationary Hospital, Boulogne. Under the care of Lt.-Colonel Butler, R.A.M.C.)

The case shown in *Fig.* 39 was admitted with a glancing wound of the left side of chest on the posterior-axillary line. The wound had apparently been caused by a piece of shell, and had not penetrated the thorax or fractured ribs.

The left arm from the elbow to the shoulder was swollen and crepitated, though no communication between the wound in the side and the arm could be found, and no track of the extension of the infection was apparent.

The patient presented the characteristic appearance of gas-gangrene toxæmia—very anæmic—skin of a transparent yellowish colour—conjunctivæ slightly yellow.

The arm was freely incised. The tissues were œdematous and emphysematous—not gangrenous. The man, however, became gradually worse, vomiting all food, and died on the tenth day from toxæmia.

FIG. 39.—DRAWING OF A PATIENT WITH HÆMOLYTIC JAUNDICE ACCOMPANYING A FATAL GENERAL TOXÆMIA FROM AN ANAEROBIC INFECTION.

Severe local gaseous cellulitis developed in the upper extremity, but not massive gangrene.

Two Cases in which the Liver was Penetrated by Fragments of Shell or Shrapnel Case. (From the Pathological Laboratory, No. 7 Stationary Hospital, Boulogne. Pathologist: Dr. Herbert Henry.)

P. M. 154.

The specimen (*Fig.* 40) shows a penetrating wound of the liver, taken from a man who lived for fifteen days after being wounded. The missile, probably a piece of shell-casing, entered the base of the thorax on the right side about four inches from the mid-dorsal line, giving rise to a hæmothorax which became infected with a streptococcus, and to drain which part of the sixth rib had been resected. On opening the abdomen some pus was found lying between the under surface of the diaphragm and the upper liver surface. The liver showed a large side-to-side wound, the lumen of which was filled with bright chrome-coloured septic material, and the

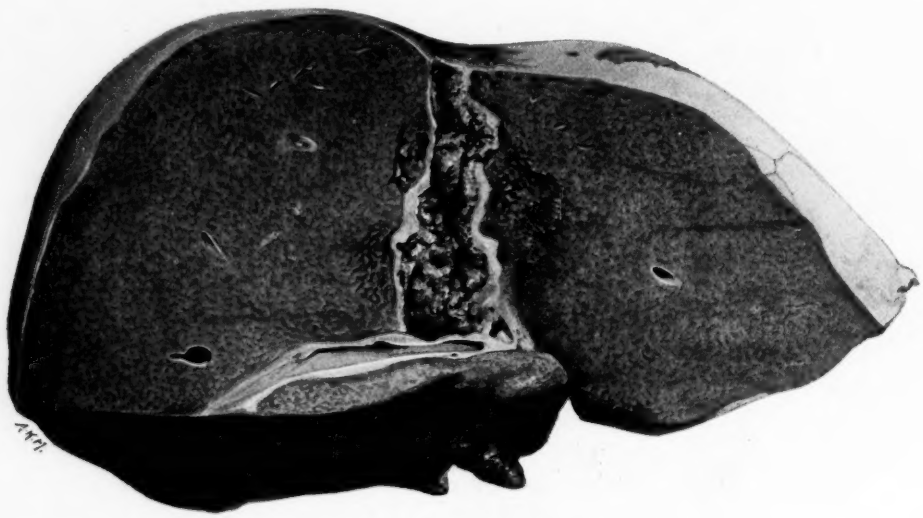

Fig. 40.—Wound of Liver.

margins of which consisted of very ragged, necrosed, bright yellow, liver tissue. Outside this was a dense, well-defined zone of fibrous tissue, which separated the septic track from normal liver. There were also to be seen patches of infarcted liver which had not undergone necrosis, and which were recovering.

There was no exit wound, nor was the missile found.

P. M. 166.

The specimen (*Fig.* 41) shows an eleven-days-old penetrating shell-wound of the liver. The point of entry was a large septic wound on the right anterior axillary fold. The thoracic wall was penetrated in the right fourth interspace in the mid-axillary line, with slight tearing of the intercostal muscles and of the parietal pleura, but with no rib damage. A large hæmothorax which had formed on the right side was found on the sixth day after injury to be heavily infected with a streptococcus, and the right pleural cavity had been drained by rib resection. The right lung showed very little sign of collapse. The upper and middle lobes were firmly glued together, and the anterior margin of this mass was perforated obliquely, the further track of the missile running more or less vertically from top to base of the lower lobe. There was laceration and perforation of the right cupola of the diaphragm. In its further course the missile had penetrated the right lobe of the liver, and was found lying embedded in, and partly protruding from, the inferior surface of the

organ. The centre of the wound track was filled with septic liquid material, heavily bile-stained. Outside this lay a zone of necrotic liver—the necrosis having supervened on infarction, followed by sepsis—and this was separated from healthy liver by a well-developed strong capsule of inflammatory fibrous tissue.

Figs. 40 and 41 illustrate wounds to the liver by fragments of shell or of shrapnel case. The two histories furnished by Dr. H. Henry illustrate a common course following these injuries. In both a suppurating hæmothorax caused death from septic absorption. In other cases the same result may follow the development of a subphrenic abscess. Injuries of this class are least dangerous when they are drained by the primary exit or entrance wound. This suggests the desirability of an early operation, both for the provision of drainage and removal of the septic shell-fragment; but with regard to the latter object, it will be noted that in the case illustrated by *Fig.* 40 the fragment was not discovered even at the post-mortem examination, a not uncommon circumstance. Operative experience goes to show that it is better in these cases to await secondary consequences than to perform primary operations, except in special circumstances. Wounds caused by rifle bullets are much less dangerous, and often heal spontaneously, with practically no troublesome symptoms.—[G. H. M.]

FIG. 41.—VERTICAL WOUND OF LIVER, WITH MISSILE *in situ*.

Two Cases of Gunshot Injuries of the Intestine. (From the Pathological Laboratory, No. 7 Stationary Hospital, Boulogne. Pathologist: DR. HERBERT HENRY.)

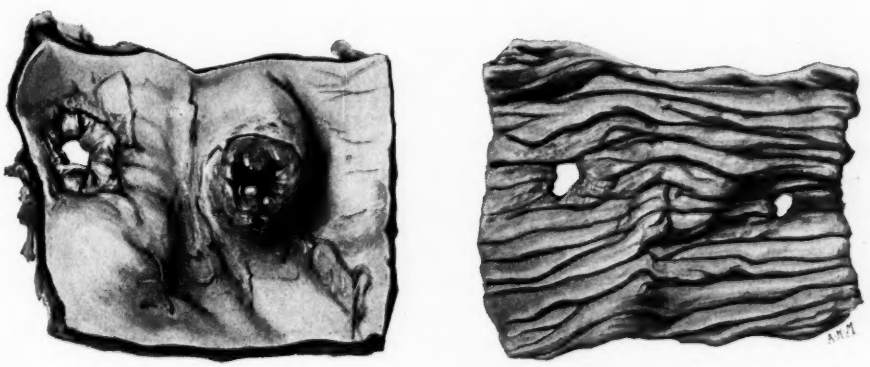

FIG. 42.—BULLET WOUNDS OF BOWEL, SHOWING PERITONEAL AND MUCOUS ASPECTS RESPECTIVELY.

P. M. 153.

The illustration (*Fig.* 42) shows side-to-side perforating bullet-wounds of the small intestine. Both specimens are from one coil of gut which has been opened

out flat, so that the left-hand picture shows the appearance of the injury on the peritoneal surface of the gut, while the right-hand one shows the appearance from the internal aspect. In the left-hand picture the aperture on the right with the swollen margin is surrounded by infarcted gut-wall, and represents the point of entry of the bullet, while the opening on the left, showing protrusion of mucous membrane, is the point of exit. The right-hand picture shows two clean-cut holes, with but little other sign of injury.

The man from whom this specimen was taken died on the ambulance train during the journey from the clearing hospital to the base, and was said to be wounded. After some search at the post-mortem, a small bullet-entry wound was discovered hidden away under the right gluteal fold. There was generalized septic peritonitis, with perforation of three coils of small intestine near the duodeno-jejunal junction. No other injury was found either in the abdomen or in the thorax. The track of the bullet could not be traced, nor was it found at the post-mortem.

P. M. 175.

The entry wound was a ragged septic hole about one inch in diameter, discharging fæcal material, and situated immediately above the anterior superior spine of the ilium on the right side. On opening the abdomen there was found generalized peritonitis, with perforation of the small intestine in two places about five and six feet from the ileocæcal valve. The specimen (*Fig.* 43) shows much tearing and laceration of the gut. The missile, an irregular fragment of shell-casing about half an inch in diameter, was found embedded in the mesenteric border of the gut in an adjoining coil of intestine. No other abdominal injury could be found.

FIG. 43.—SHELL WOUND OF BOWEL.

Figs. 42 and 43 illustrate injuries to the small intestine caused by a rifle bullet and a fragment of shell respectively. Both injuries are of about three days' standing. The contrast between the ragged laceration caused by the fragment of shell, and the contused circular openings produced by the bullet, is very striking. The characters of the entry and exit openings in *Fig.* 42 are well shown. As seen from the inner surface of the gut, the resemblance to a pathological perforation, save that the surrounding mucous membrane is healthy, is characteristic of an injury at this date after its infliction. The smaller size of the exit wound depends upon the continuing protrusion of the mucous membrane.—[G. H. M.]

GUNSHOT INJURIES OF THE SKULL:

AN ANALYSIS OF A SERIES OF TWENTY CASES.

By CECIL A. JOLL, London.

I. **Introduction.** — The present article is intended as a preliminary communication dealing with some of the more practical points in the symptomatology and treatment of a small series of cases: the first twenty cases treated by the writer. The majority were patients at the Majestic Hospital in Paris during the time that the writer was in surgical charge there, but a few cases were treated while on a short visit to a field hospital. Nearly all the patients who survived were kept under observation for periods long enough to enable a fair estimate of the prognosis to be made, and one or two have been re-examined lately in this country.

In the series there is a wide range in the severity of the wounds, and the one thing common to them all was the treatment—all were operated on.

As to the propriety of this, it seems almost impossible to judge at this time. Surgical opinion varies from that of absolute non-interference to that of routine operation in all cases, while a large number of surgeons steer a middle course and apparently favour an eclectic attitude.

The results achieved in this series cannot pretend to settle this difficult question; many more cases must be treated and a greater period must elapse before that is possible.

II. **General.**—

1. *The Period elapsing between the Receipt of the Wound and Admission to Hospital.* This varied widely, six of the series (Nos. 12, 13, 16, 17, 19 and 20) were seen within twenty-four to forty-eight hours of the receipt of the wound; but most of the cases were seen four or five days after being wounded; while in *Case* 18 nine days had elapsed, and in *Case* 1 three weeks had passed, before admission. In four of the cases (Nos. 3, 4, 5 and 9) it was not possible to find out exactly how long the interval had been.

2. *The General Condition on Admission.* Shock and concussion were present in varying degrees in the recent cases, the evidences being a feeble pulse of low tension, some degree of unconsciousness or incoherence, and sluggish reflexes. In a few, however, nothing more than headache was complained of.

The mental condition was normal in *Cases* 15 and 19; in three (*Cases* 3, 4 and 5) there was profound coma; in several drowsiness or apathy; in *Cases* 8 and 11 irritability; in *Cases* 14 and 17 delirium; and in *Case* 1 maniacal excitement. In *Case* 9 there was complete sensory aphasia (see also Dr. Gordon Holmes's note later). Although most of the cases had to be carried into the hospital, one or two were well enough to walk in.

3. *The Motor System.*—In six cases (Nos. 2, 6, 7, 12, 14 and 19) there was spastic hemiplegia, five left-sided and one on the right. In *Case* 17 spastic paraplegia and spastic paralysis of the right arm co-existed.

4. *The Sensory System.*—The condition of the patients and the exigencies of work made it very difficult to investigate thoroughly before operation the sensory system in any but a few cases. In *Cases* 6, 12 and 19 there co-existed with the hemiplegia partial hemi-anæsthesia to touch and pin-prick—the other sensations were not examined.

5. *Special Senses.*—There were no cases of special visual defect except those noted in connection with actual injuries to the eye, referred to below (*Cases* 10, 15 and 16).

In *Case* 20 there was some deafness in the left ear.

Taste and smell were not investigated.

III. The Local Appearances.

1. *The Wound in the Soft Parts.*—Five of the cases (Nos. 4, 8, 14, 15 and 18) were certainly due to shrapnel or fragments of shell, the remainder were caused by rifle bullets. All the wounds were more or less septic; some showed merely a small amount of pus exuding from a sodden wound; others were extremely foul, with a mixture of blood, pus, and decomposing extruded brain matter smeared over the wound and its neighbourhood.

Nearly all had received some attention before admission, but under the conditions of the great retreat it was often impossible to do much for the cases, so that several arrived with foul dressings which had been untouched for days.

It was something of a surprise to the writer to find that all the bullet wounds of the skull were septic, as this appeared to be contrary to the experience in the South African war,* but it appears that in both the Balkan and Russo-Japanese wars sepsis was the general rule in these cases. The different conditions of atmosphere, soil, and rainfall, and the relatively long periods which had elapsed between injury and operation, may be important factors in the determination of sepsis in this series.

The shape of the wound was roughly circular in the perforating and penetrating wounds due to rifle and shrapnel bullets at ordinary ranges (*Cases* 10, 13, 18). The glancing bullets made either a long oval track (*Case* 12), or, where the soft tissues were thicker, two small ovoid wounds with an undermined bridge of soft tissues between.

The more irregular pieces of shell produced correspondingly irregular wounds.

In *Cases* 3, 5 and 14 typical 'explosive' wounds were present; large irregular foul wounds with protruding cerebral tissue being associated with an extensive comminuted fracture of the skull.

2. *The Lesion of the Skull.*—Corresponding to the several types of wound in soft tissues just described were various degrees of skull injury. The direct perforating and penetrating wounds (three of each in this series) were associated with small perforations in the skull, a little fissuring around the hole,

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* Makins, *Surgical Experiences in South Africa.*

and small fragments of bone, chiefly from the inner table, carried various distances into the underlying brain. In *Case* 13, a perforating rifle-bullet wound passing transversely across the frontal region, it was very difficult to determine in which direction the bullet had passed, for the wounds were of about equal size, and in both, fragments of bone were found embedded an inch or more deep in brain tissue (*Fig.* 44). The only clue present was a slight pouting of the wound on the right side, suggesting that as the exit wound. On theoretical grounds it would be expected that the exit wound

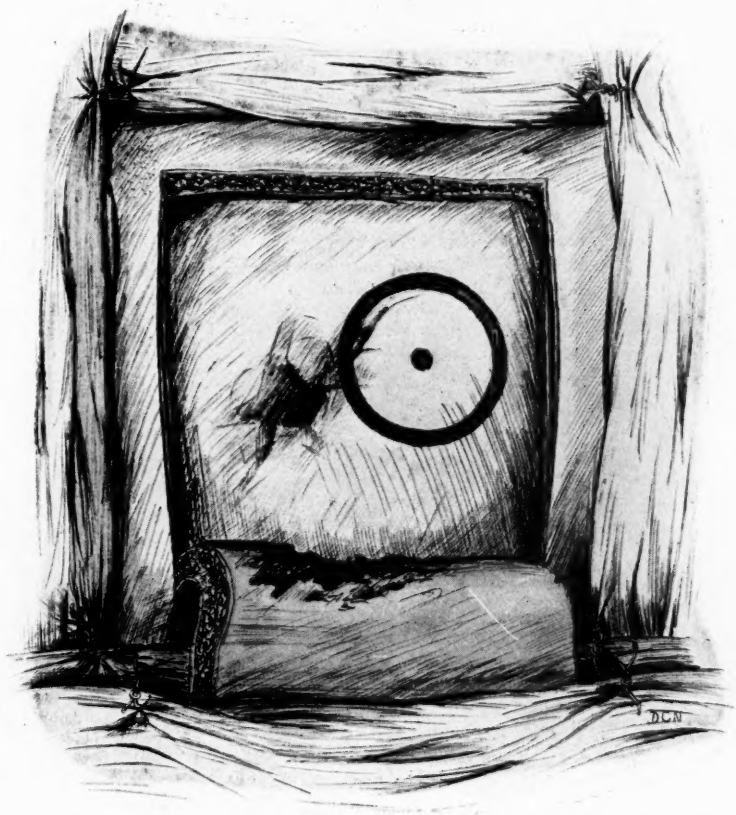

FIG. 44.—RECTANGULAR FLAP OF SOFT TISSUES TURNED DOWN.
Trephining commenced.

would have shown more extensive comminution of bone than the entrance wound, but this could not be established in this case.

In *Cases* 3, 5 and 14 (particularly the last) 'explosive' effects were present, the result of rifle and shrapnel wounds at close quarters. There were widely radiating fissure-fractures of a large area of the skull, with separation of sutures, giving the sensation of a crushed egg-shell to the palpating hand. In *Case* 14 the parieto-squamous suture on the right gaped half an inch, and the squamous temporal bone lay elevated half an inch above the general level of the skull. In these three cases it was impossible (and unnecessary) to use

a trephine, for nowhere was the skull sufficiently rigid to bear the pressure of the instrument, and very large pieces of skull could be removed *en bloc* with forceps.

Case 2, though not so severe as those just described, showed rather extensive comminution of the skull, with some separation at the right parietosquamous suture; this case recovered (see *Figs.* 49 and 50).

There were ten cases of fracture by glancing bullets (rifle and shrapnel). The preponderance of this type suggests strongly that a larger proportion of these survive than in the other two classes, in which probably a large percentage die at once or soon after the injury. It is possible, however,

FIG. 45.—AREA OF BONE REMOVED AROUND WOUND.

that the modern pointed bullet has a special tendency to produce a glancing wound, since it is believed generally that its stability is less than that of the older blunter bullets, and therefore is more readily deflected from its original course on striking a hard, smooth, rounded surface such as the skull.

Nearly all the wounds in this series were received in open fighting, so that it is not possible to explain the large proportion of glancing wounds as being the result of trench warfare, a type of fighting particularly likely to result in tangential wounds of the skull.

These glancing wounds produced a gutter type of depressed fracture of the skull of varying shape and size, with some comminution of the outer table

and a larger area of comminution of the inner table, and in every case but one some depression of fragments of skull, chiefly inner table, into the underlying brain matter. In the majority there was one long oval gutter, but in one or two there were two oblique holes in the skull, bridged by some comminuted fragments of the outer table.

In *Case* 15 (see *Fig.* 45) a very small groove was produced in the frontal bone by a chip of shell, without any comminution of the surface of the bone; there was, however, considerable fragmentation of the inner table (see *Fig.* 47), with bruising of the dura but without any penetration of the brain tissue.

3. *The Injury to the Brain; the Retention of the Projectile.*—In the penetrating, perforating, and gutter injuries, the brain in all cases except *Case* 15, was lacerated by fragments of bone, and sometimes by projectiles. The brain matter in the neighbourhood was pulped, semi-fluid and under tension; it escaped from the wound at operation, tending to carry out with it some of the foreign particles, e.g., bone, etc. In *Cases* 8 and 18 large cerebral abscesses were found in the frontal lobes; one of these cases died, the other recovered. In the 'explosive' injuries there were large portions of brain matter extruded between the fragments of skull, and the whole area was excessively foul. In *Case* 17 the fragments of bone had injured the superior longitudinal sinus, and it was filled with clot. In *Cases* 4, 8 and 18 (see *Fig.* 48) portions of shell or bullets were present in the brain. In one of these (*Case* 8) the shrapnel bullet was removed with ease; in the other two the foreign bodies were left—both died.

4. *Co-existing Wounds.*—The bullet in *Case* 10 caused some degree of injury to the left eye, though it did not actually traverse it. The pupil was dilated, there was hyphema and subconjunctival ecchymosis, and the eye movements were much limited. The patient could just count fingers on admission, but before leaving the hospital sight was nearly normal. He had also a fracture of the right malar bone through which the bullet had emerged, but this gave no trouble.

In *Case* 15 there were numerous shell wounds of soft parts scattered about the body; none of them were serious.

In *Case* 16 the bullet penetrated the left eye in its exit, destroying it completely, and it was necessary to remove it.

IV. **Diagnosis of Skull from Scalp Wounds.**—This was not always easy; neither the appearance of the wound nor the condition of the patient afforded a reliable criterion. *Case* 18 complained merely of headache; he had been treated elsewhere as a mere scalp wound, yet he had a frontal abscess containing four ounces of pus. It is unwise to probe these wounds, septic as they are.

All doubtful cases, therefore, were explored under anæsthesia; usually this necessitated turning down a flap of soft tissue. In one case only was the wound found to be confined to the soft parts (it is not included in this series).

V. Treatment.—

1. *Should all Cases be subjected to Operation; and if so, when?*—The routine exploration of these cases has been advocated strongly by Sir. G.

Makins,* and by V. Oettingen from his experiences in Manchuria.† The adherents of this method claim that it minimizes the risk of abscess and meningitis, and avoids the danger of the more remote effects, physical and mental, that result from the chronic irritation by depressed fragments of bone.

On the other hand there are surgeons who deprecate interference, except in so far as the cleaning and dressing of the wound are concerned. This school claims that the spread of sepsis is favoured by operation, and that the mortality is increased by operation. It teaches that the brain, if left alone, is able to localize sepsis, that abscesses may become absorbed, and that operation should be resorted to only in the presence of definite indications that sepsis is spreading. The advocates of this method deny the applicability of statistics based on the South African campaign to the conditions of this war, and they

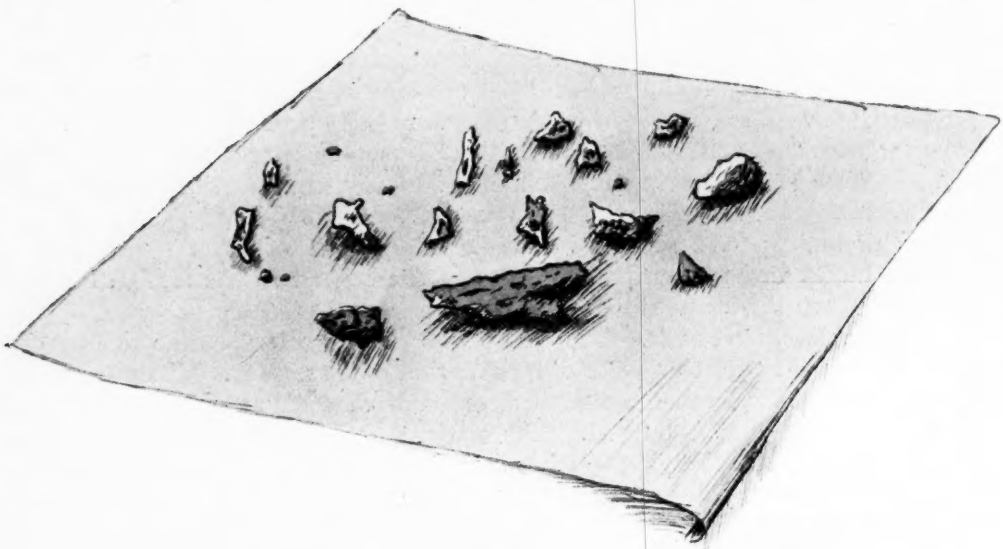

FIG. 46.—LOOSE FRAGMENTS OF BONE REMOVED FROM BRAIN.
Some of these were 2 inches deep in the brain tissue.

claim that the greater frequency of shell and shrapnel wounds and the greater prevalence of sepsis in this war render the adoption of routine operation unsafe and undesirable. With regard to the latter methods the writer has had no experience. All the cases of this series were subjected to operation as soon as possible. It is significant that of the cases that did badly all had received the wounds several days before; three of the five already had spreading meningitis, and a fourth had a large cerebral abscess. Though it is impossible to be sure that this could have been obviated by early operation in all, it seems probable that in *Cases* 4, 5 and 18 early operation would have done good; in *Cases* 3 and 14 death would have resulted whatever line of treatment had been carried out.

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* *Surgical Experiences in South Africa.*
† *Münch. med. Woch.*, 1906, p. 218.

Should operation be undertaken at once? It must be remembered that many cases have come long distances by rail and ambulance, and have had little rest and food; and although in this series no interval was allowed between admission and operation, the writer is inclined to think that delay of a few hours for rest and stimulation may be desirable in some cases, and that one or two cases in the series were affected prejudicially by being hurried to the operating theatre.

2. *Technique.—a.* Routine use of *x* rays.—Every case before operation was examined by the screen, and one or more skiagrams taken. Evidence of the presence of foreign bodies was obtained in three cases. *Fig.* 48 shows *Case* 18, with one large and many small pieces of shell embedded in the skull and brain.

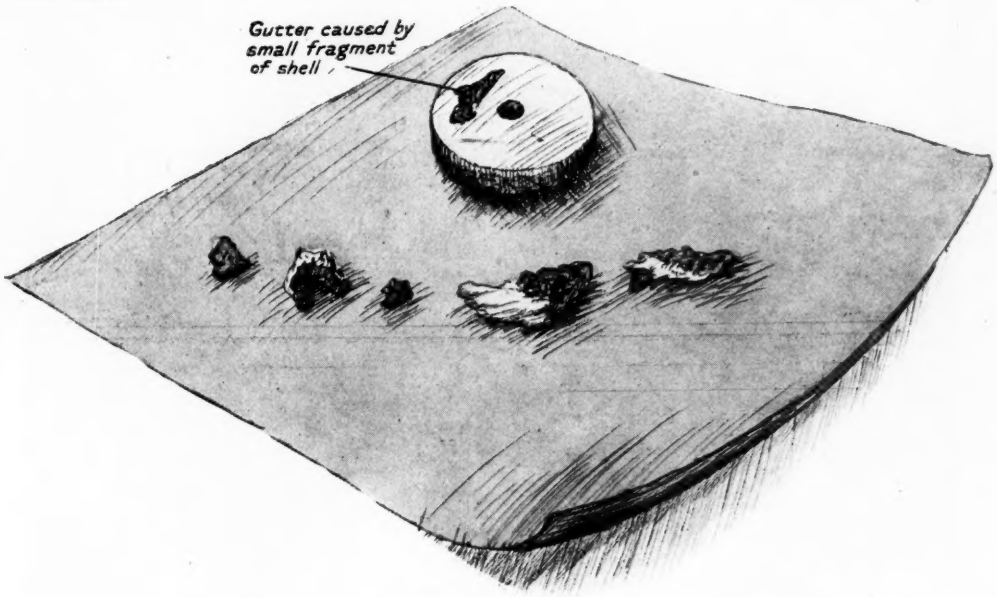

FIG. 47. TREPHINE BUTTON AND LOOSE FRAGMENTS OF BONE.
In this case the only external evidence was the small gutter indicated in the figure. The loose fragments were inner table. The dura was bruised but not torn through.

b. Anæsthetic.—Restless and irritable patients were given morphia (gr. $\frac{1}{4}$ to gr. $\frac{1}{3}$) before operation. Pure chloroform, or a mixture of chloroform and ether on the open mask, was used. In one or two comatose cases practically no anæsthetic was required.

No difficulties in anæsthesia were met with.

c. Details of the operation.—The scalp was prepared by thoroughly lathering the whole of it with ether soap to which hydrogen peroxide was added, the latter helping to loosen clotted blood and other débris from the hair. The whole scalp was now shaved closely with a safety razor, swilled over with 1–1000 watery solution of biniodide of mercury, followed by vigorous rubbing with swabs soaked in 1–500 solution of mercury biniodide in 90 per cent alcohol. Although under ordinary circumstances an advocate of the dry aseptic technique, the writer considers these cases as wholly unsuitable

for anything but a decided antiseptic treatment. Towels were stitched to the scalp with silkworm-gut to limit the operation field (see *Figs.* 44 and 45). A rectangular flap of soft tissues, including near its centre the wound or wounds, was now outlined with a needle and then rapidly turned down. Bleeding points were picked up with Kocher's artery forceps. In a few cases Cushing's scalp tourniquet was used, but in the majority it was found to encroach too much on the area of operation, and was therefore discarded. From this stage onwards an assistant kept a fine stream of a hot solution of biniodide of mercury (1–4000) playing on the wound, with the object of minimizing hæmor-

FIG. 48.—SHOWING ABSCESS OF FRONTAL LOBE FOLLOWING PENETRATING SHELL WOUND. Pieces of shell in brain.

rhage, keeping the wound clear of blood, and washing away all septic matter at once. A 1¼ in. Horsley trephine was now used to remove a 'button' of bone from the immediate vicinity of the skull injury, and the comminuted fragments were removed with forceps. In a few of the cases no trephine was used, the fragments being loose enough to be removed with forceps. The dura was next examined, and the brain explored very carefully with a probe, forceps, or the little finger, according to the size of the hole available in the dura. Depressed fragments of bone were now removed, the stream of biniodide helping materially in this process. No attempt was made to enlarge the hole in the dura mater, as it was deemed likely to increase the risk of

meningitis by opening up the subdural space when perhaps protective adhesions had already formed.

The hole in the skull, however, was enlarged considerably with Hoffmann's forceps, leaving a defect in the skull nearly 4 in. square. Any tags of soft tissue adherent to the edge of the hole in the dura mater were pared away with fine scissors, and a rubber tube was inserted through the hole; the damaged part of the flap around the original wound was cut away, the raw surface painted with pure carbolic acid, and the tube was brought through this hole in the flap and fixed with a stitch. The flap of soft tissues was then replaced, and sewn accurately in position with interrupted silkworm-gut sutures passed with a curved Bonney's needle, the rectangular shape of the flap making it easy to replace it in exactly correct position. A large antiseptic compress was now applied, and the whole fixed with a bandage. A prophylactic dose of 10 to 30 c.c. of antetetanic serum was injected into the spinal canal in every case.

d. Should bullets, etc., be removed? In *Cases* 4, 8 and 18 of the series, bullets or shell fragments were found by *x* rays embedded in skull or brain. In *Case* 8 the bullet was found directly under the dura at the operation, and was readily removed. In *Cases* 4 and 18 Sheen's probe was used to localize the foreign body. In the former case it was easy to touch the bullet with the probe and thus obtain the telephone effect, but attempts to grasp it failed. This patient died, and at autopsy the bullet was found deeply embedded in the petrous bone. In *Case* 18 only a tentative effort was made to remove the portion of shell.

As far as this series is concerned it gives support to the view that it is wiser not to attempt to remove the bullet unless it obtrudes itself on the surgeon's notice lying in an easily accessible place. The use of bullet probes seems likely to act as a stimulus to repeated efforts to remove bullets better left alone, and thus to lead to laceration of the brain and spread of infective material. In *Case* 4 harm was undoubtedly done by these efforts to remove the bullet; it would have been wiser not to have tried.

3. *The Post-operative Treatment.*—All cases were given saline by the rectum for about twenty-four hours after the operation. Hexamethylenetetramine in 15-gr. doses was given four-hourly, in the hope that sepsis might be minimized by the excretion of that drug into the cerebrospinal fluid as formaldehyde; but there is no direct evidence in this series as to its value. Morphia, bromides, hyoscine, and other sedatives had to be given to several of the cases for some days after. *Case* 1 had to be kept under the influence of sedatives throughout his stay in the hospital. Only two cases healed by first intention (*Cases* 9 and 15). In most some suppuration occurred from the region of the original wound, and in one or two the operation incision also became infected.

In *Cases* 2, 8 and 18 large cerebral herniæ followed; in one or two others small herniæ occurred. All were treated by painting the protuberant mass with pure formalin daily until a large slough formed. This was allowed to separate, and the raw surface left was painted with absolute alcohol twice daily. All recovered except *Case* 18, in whom the hernia increased in size; the patient became drowsy, with a high temper-

ature, and, in spite of a second (decompressive) operation undertaken nineteen days later, combined with repeated lumbar puncture, he died. *Figs.* 49 and 50 show one and the same case. In the former figure the hernia is seen during the stage of treatment with formalin; in the latter the hernia has disappeared and the wound healed. This case was recently re-examined, and the scar found rather depressed.

In the other fatal cases there was no opportunity for further decompressive measures. Three died within twenty-four hours of admission; another, *Case* 14, lived six days after admission and thirteen days after the injury, but he was always a hopeless case.

FIG. 49.—CASE OF CEREBRAL HERNIA TREATED BY PURE FORMALIN AND ABSOLUTE ALCOHOL.

FIG. 50.—Same patient as in FIG. 49, one month later.

Choice of Site for Secondary Decompressive Operations.—In *Case* 18 referred to above, the original opening in the skull was enlarged; this, in the writer's opinion, was a mistake. It would have been better to make a separate decompression on the opposite side of the skull. Secondary operation at the site of the original wound must tend to spread sepsis and infect the subarachnoid space; while an operation area remote from the wound will have the best chance of remaining uninfected.

VI. **Results.**—The mortality in the series was 25 per cent, four (20 per cent) dying from meningitis and one (5 per cent) from shock. Of those who recovered, one was discharged to an asylum apparently hopelessly demented; the rest showed no marked mental change except *Case* 9, who remained aphasic during his stay at the hospital, but improved somewhat towards the end.

Case 9.—C. *Dr. Gordon Holmes's note:* Ordinary spontaneous speech is a little affected. He can make himself understood easily. He also understands spoken

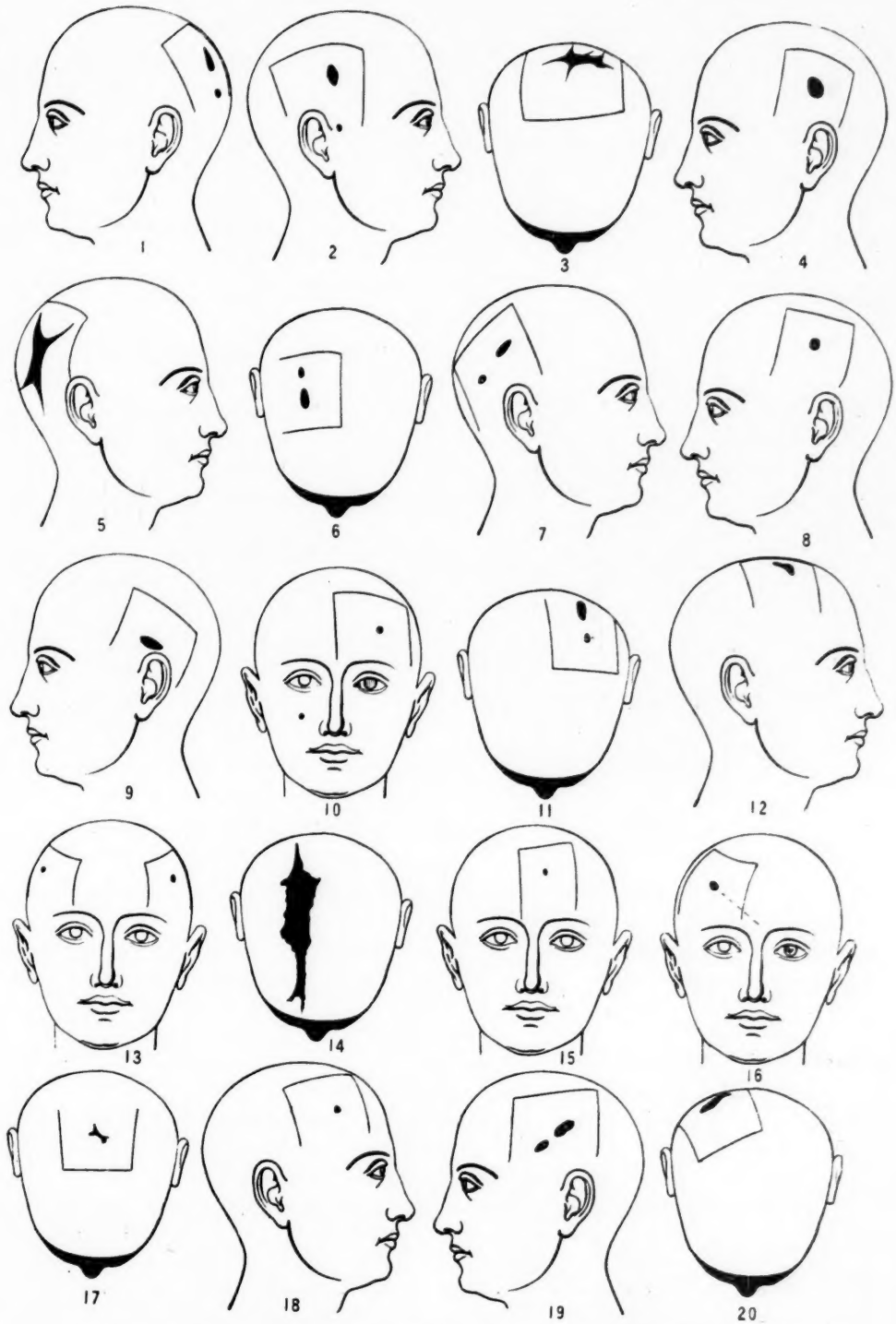

FIG. 51.—CHART SHOWING POSITION OF WOUNDS AND THE APPROXIMATE SIZE OF THE FLAPS EMPLOYED IN THE TWENTY CASES.

No.	Name	Nationality	Age	Date			Main Symptoms	
				Of Wound	Of Admission	Of Operation		
1	B. F.	French	27	22. 8. 1914	18. 9. 1914	18. 9. 1914	Extreme restlessness, childish speech alternating with maniacal excitement	Glan pari
2	A. S.	British	26	13. 9. 1914	23. 9. 1914	23. 9. 1914	Complete left hemiplegia. Dull mentally	Comm pari
3	W. W.	British	These three cases were comatose on admission, and details of dates were not obtainable		19. 9. 1914	19. 9. 1914	Coma. Hyperpyrexia. Hernia cerebri	Exp in o
4	J. W.	British			19. 9. 1914	19. 9. 1914	Coma. Wound in left parietal region	X ray bedd
5	J. R. W.	British			19. 9. 1914	19. 9. 1914	Coma	Comm pari
6	E. P.	French	22	7. 9. 1914	12. 9. 1914	12. 9. 1914	Wound in right parietal region. Complete left hemiplegia	Glanc depr
7	R. C.	British	27	20. 9. 1914	23. 9. 1914	23. 9. 1914	Wound in right parietal region. Left hemiplegia	Glanci pari
8	L. B.	French	30	16. 9. 1914	23. 9. 1914	23. 9. 1914	Irritable. Slow pulse. Weakness in right side	Penetr pari
9	C.	French	?	?	23. 9. 1914	23. 9. 1914	Bullet wound over left ear. Aphasia	Glanci
10	W. P.	German	32	9. 9. 1914	13. 9. 1914	13. 9. 1914	Drowsy. Headaches	Perfor fronta
11	H. G.	French	30	10. 9. 1914	14. 9. 1914	14. 9. 1914	Headache. Irritability	Glanci pari
12	A. O.	Senegalese	24 (?)	10. 10. 1914	11. 10. 1914	11. 10. 1914	Paralysis in left leg and left arm. Unconscious	Glanci of rig
13	S. C.	French	20	11. 10. 1914	12. 10. 1914	12. 10. 1914	Drowsy. Headache. Unequal pupils	Perfor region
14	J. R.	German	23	7. 9. 1914	14. 9. 1914	14. 9. 1914	Left hemiplegia. Semi-conscious. Delirium	Explo volvi tempo Large
15	B.	Moroccan	?	3. 11. 1914	10. 11. 1914	10. 11. 1914	Drowsy. Headache	Chip o fronta
16	A. B.	Algerian	25	20. 10. 1914	22. 10. 1914	22. 10. 1914	Semi-conscious. Left eye destroyed	Perfora right throug
17	A. P.	French	28	20. 10. 1914	22. 10. 1914	22. 10. 1914	Spastic paraplegia. Right arm paralyzed. Delirium	Glancin sagitta Rolan
18	V.	French	27	31. 10. 1914	9. 11. 1914	9. 11. 1914 & 28. 11. 1914	Headache	Penetra frontal
19	B. E.	French	36	10. 10. 1914	12. 10. 1914	12. 10. 1914	Right hemiplegia. Left deafness.	Glancing parieta
20	R. B.	French	30	11. 10. 1914	13. 10. 1914	13. 10. 1914	Drowsy. Headache	Glancing

Diagnosis	Treatment	Result	Remarks
Glancing bullet wound in posterior parietal region near mid-line	Trephining	Improved	This case was first seen over three weeks after injury
Comminuted fracture in right parietal region by bullet	Trephining	Recovered. Hemiplegia still present. Mentally clear	Large hernia cerebri (see *Fig.* 61) treated with pure formalin
'Explosive' effect of bullet wound in occipital region	Trephining and decompression	Died	
X rays show shrapnel bullet embedded in petrous bone	Trephining	Died	Bullet 'felt' with telephone probe. Not removed
Comminuted fracture in right parieto-occipital region	Trephining and decompression	Died	
Glancing bullet wound in skull—depressed fragments	Trephining	Recovered	Patient left hospital 12. 11. 1914. Hemiplegia clearing up. Leg still weak
Glancing bullet wound in right parietal bone	Trephining	Recovered	Hemiplegia quite cleared up. Two fits 26. 9. 1914—none since
Penetrating shrapnel wound in left parietal region. Abscess of brain	Trephining. Bullet removed. Abscess drained	Recovered	Went out well
Glancing bullet wound in skull	Trephining	Recovered	Aphasia improved
Perforating bullet wound in left frontal region	Trephining	Recovered	Exit wound over right malar. Left eye injured
Glancing bullet wound in posterior parietal region (left)	Trephining	Recovered	
Glancing bullet wound in upper part of right anterior parietal bone	Trephining	Recovered	
Perforating bullet wound in frontal region	Both sides trephined	Recovered	
'Explosive' shrapnel wound involving right frontal, parietal, temporal and occipital bones. Large septic hernia cerebri.	Trephining. Large area of bone removed	Died 20. 9. 1914	Patient lived thirteen days in spite of the very severe type of injury
Chip of shell made small dent in frontal bone (see *Fig.* 47)	Trephining	Recovered	There were several other shell wounds in soft tissues
Perforating bullet wound—entered right frontal bone and emerged through left eye	Trephining. Left eye excised	Recovered	
Glancing bullet wound crossing sagittal suture near upper end of Rolandic areas	Trephining	Recovered	Paralysis nearly cleared up
Penetrating shell wound of right frontal lobe. Abscess	Trephining. Retrephined 28.11.14	Died	Fragment of shell could not be removed
Glancing bullet wound in left parietal region	Trephining	Recovered	Paralysis improved
Glancing wound right occipital bone	Trephining	Recovered	

speech, and can obey orders given him. He can, however, really only give the names of objects shown to him, as knife, fork, bread. When the name of the object is spoken to him, he can recognize the object to which each sound applies. He is not able to read, and cannot understand the meaning of written words. He is not able to write anything more than his name. He does not use wrong words in speech, but frequently is unable to find the names of objects about which he wants to speak.

Opinion.—A pure sensory aphasia affecting chiefly the auditory word centre. Probably no direct injury to the angular gyrus. The abnormal mental state—depression and occasional excitement—is very much as is often found in such aphasic patients, and is, I have no doubt, due entirely to the aphasia. The prognosis is fair; he will probably, however, have some permanent defect in internal speech.

Of the cases of hemiplegia that lived, one (*Case* 7) recovered completely; the others all improved sufficiently to be able to walk with or without crutches. In *Case* 2, re-examined about a month ago, the patient cannot use the arm at all; the face is weak on the hemiplegic side; but the patient is able to walk without a stick, though he prefers to use one.

Case 6.—E. P. *Dr. Gordon Holmes's note a month after operation.* Usual fields and movements of eyes good. Pupils equal, and react to light and accommodation. Face symmetrical, tongue protruded straight. Slight rigidity and weakness of left arm, especially of the hand movements. Left leg rigid and weak, relatively much more so than left arm; he does not perform any movements with left leg, rather because he will not make an effort to do so. Abdominal muscles act well on both sides.

Reflexes.—On the right normal; on the left all tendon reflexes exaggerated, ankle clonus present, plantar reflex extensor, abdominal reflexes on left diminished.

Sensation.—Touch is considerably diminished on the left arm and leg. Pin-prick is felt less well on the left side of the body, especially so on the left arm and left foot. Sense of position is slightly defective in the left hand and in the left leg.

On Nov. 12 the left arm was practically normal both in motor and sensory functions, but there was still some spasticity of the left leg. He was able, however, to walk without a stick. Seen again, Jan. 20, 1915, he was walking well, with a mere trace of spasticity.

In *Case* 7 referred to above, the patient had two epileptic attacks three days after operation, and was a little 'strange' in his manner for a week or two afterwards, but he had no recurrence of the fits.

In *Case* 17 unfortunately it was not possible to trace the case long enough to see what influence the injury to the superior longitudinal sinus had on the progress of the patient, but the paralysis was 'better' when last heard of.

In conclusion, my best thanks are due to Dr. Gordon Holmes for the notes on *Cases* 6 and 9; to my colleague, Mr. Ulysses Williams for the radiograph (*Fig.* 48); to Mr. D. C. Norris for *Figs.* 44 to 47; to Mr. Cecil Howard, of Paris, for the photographs, *Figs.* 49 and 50; and to Mr. F. H. Schwind for keeping the notes of the cases so carefully during trying times.

SOME NOTES ON GUNSHOT AND OTHER WOUNDS.

By Major F. POWELL CONNOR, I.M.S.,
and Lieut. HAROLD MOWAT, R.A.M.C.

All those who have been working at one or other of the large military hospitals during the last six months have seen many cases of the greatest surgical interest. Many of these have been published; many more will be published in the near future; but the great majority will only be known to those responsible for their treatment.

Fig. 52.—Fracture of Ulna.
Loose splinters of bone extracted as far as possible.

Fig. 53.—Fracture of Ulna.
Splinters replaced as far as possible. Compare with *Fig.* 44.

The cases referred to here are all of some interest, and the *x*-ray pictures illustrate them admirably. All the patients were Indians belonging to various races, who were treated at one of the Indian General Hospitals.

Figs. **52** and **53** illustrate two separate cases. A lesson is to be learnt here as regards the treatment of a badly-splintered bone. In the first case

several of the loose fragments of bone were removed—'somewhere in France'; in the second, every small splinter has been treasured and placed in as good a position as possible. There can be no doubt as to which of the two will prove the more useful forearm. It is necessary sometimes to remove pieces of bone, but even then they can often be replaced. These things are not sufficiently dwelt on in books, and practice is a slow teacher.

Some of the wounds received from bombs and hand grenades are ghastly in the extreme. The metallic foreign bodies are very numerous, contamination with soil, etc., is almost the rule, and the vitality of the part is terribly interfered with owing to the diffuseness of the injury. *Figs.* 54 and 55 represent

FIG. 54.—BOMB WOUND OF HAND.
The thumb has been blown away; tissues full of metal fragments.

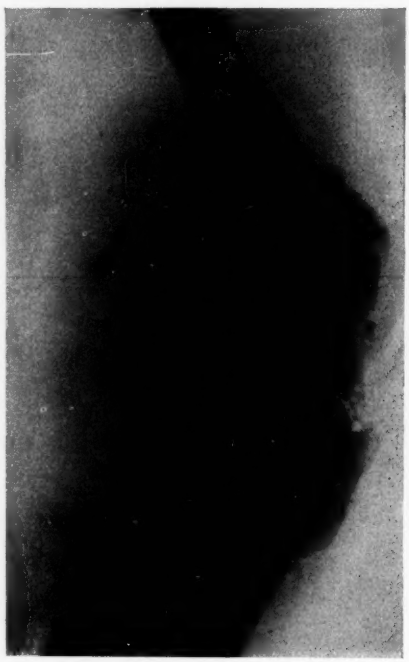

FIG. 55.—BOMB WOUND OF ELBOW.

injuries of this type. In the first, the thumb had totally disappeared, there were innumerable small metallic fragments buried in the tissues, and the whole palm was a disorganized mass, stinking, and oozing foul pus. The case cleaned up gradually, and the hand was certainly worth saving. The bomb wound of the elbow differs in character, and was probably produced by a large fragment of the bomb bursting through the joint and completely disorganizing it. There is very little to be seen in the way of foreign bodies. The provision of proper drainage and suitable extension led to rapid improvement. Extension is not easy to apply in these cases as a rule, owing to the large area of the raw surface, the excessive discharge, and the amount of swelling; but it is an essential for a successful result; a movable joint may even be obtained.

The excellent results obtainable by manipulation and weight extension can be seen by reference to *Figs.* 56 and 57. This patient, a Mohammedan cavalryman, was first seen by us about ten days after he had been wounded. The humerus had been fractured by a rifle bullet, and the condition of the bone is shown in *Fig.* 56. The splints were removed, relaxation of the muscles was obtained by an anæsthetic, and the fragments were properly manipulated into position. A light internal angular splint was applied, and extension commenced at once. The second skiagram, *Fig.* 57, was taken a month later, and the perfect alignment can be easily seen. The functional result was also very satisfactory. The value of the small fragments of bone round the seat of fracture, which are acting in the same way as 'bone grafts,' is also apparent.

FIG. 56.—FRACTURE OF HUMERUS BY RIFLE BULLET.

FIG. 57.—Same case as *Fig.* 56, one month later, after treatment by extension. Note the 'bone-graft' action of the splinters.

A Sikh patient was admitted into the hospital after treatment for about ten days in other hospitals. He was in a feeble and exhausted condition. There was a gunshot wound above the right hip which penetrated the right ilium, and from this there poured an abundant fæculent discharge. An *x*-ray plate revealed the condition shown in *Fig.* 58. The ilium was perforated, and outside the dorsum ilii several broken-up fragments of the bullet lay embedded in the muscle. But, curiously, no piece of bullet could be found inside the pelvis, though it is almost certain that one or more fragments must

have entered through the perforation. The obvious explanation is that the intrapelvic fragments must have perforated the cæcum or other part of the bowel and then been passed by the patient without his knowledge.

This patient rapidly improved, whilst the fæculent discharge steadily lessened. The hole in the ilium also began to close after a few weeks, as is seen in *Fig.* 59. The drainage tube can be seen penetrating as far as the depression on the dorsum ilii, and several fragments of bullet still remain. The man eventually proceeded to India in a hospital ship as convalescent.

FIG. 58.—BULLET WOUND THROUGH THE ILIUM.

A young Pathan was admitted for a bullet wound of the skull. There was a discharging wound, rather larger than a sixpenny piece, three and a half inches above and one inch behind the left external auditory meatus. The scalp wound led down to an irregular, gutter-shaped fracture of both tables of the skull. No obvious depressed bone could be seen or felt.

FIG. 59.—Same case as *Fig.* 58, some weeks later. Wound in ilium is closing.

The patient was recovering from concussion, and there was some evidence of compression of the brain. About fourteen days had passed since the wound had been inflicted. The intellect was dulled and his memory impaired; the pupils were somewhat dilated, but reacted readily to bright light; the vision was markedly affected, and there was very slight external strabismus. There was no optic neuritis or other change in the fundus, and no motor paralysis of the limbs or trunk. The patient complained of severe headache; there was no vomiting.

A print of the *x*-ray plate is reproduced in *Fig.* 60. The bullet was carefully localized, and found to lie about two and a half inches from the cranial wound, with its apex pointing upwards and to the right, in the direction of the vault of the skull. A small piece of the inner table was seen to be depressed.

Operative interference was postponed, as the patient was improving slightly and the wound was still very foul. But after ten days, when the

man's condition had improved in these respects, it was decided to remove the bullet and the piece of depressed bone. The operation proved an easy one,

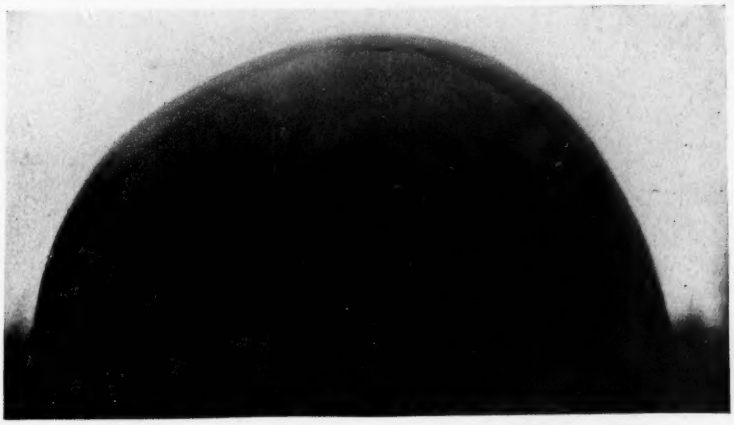

FIG. 60.—BULLET WOUND OF SKULL. Bullet *in situ*.

in spite of the depth of the bullet—perfect localization and the use of a telephone bullet-probe removed all difficulties.

A flap was turned down, the cranial wound enlarged by nibbling forceps, the depressed fragment removed, and the telephone probe passed at once down to the bullet along the granulating track. The bullet was grasped by a pair of narrow-bladed bullet-forceps, and although the blades slipped several times owing to the acutely conical shape of the bullet, it was very soon removed. A certain amount of débris and dirt came away at the same time, and the track was carefully wiped out with strips of gauze. There was little hæmorrhage. A horsehair drain was inserted.

FIG. 61.—COMMINUTED FRACTURE OF FEMUR.

The reaction after the operation was severe, and the patient's condition remained somewhat critical for two days; but at the end of a week he was on the high road to recovery, and he was able to proceed to

India with a healed wound at the end of a month. He was greatly gratified because the base of the bullet was distorted owing to the hardness of his skull!

FIG. 62.—FRAGMENT OF BULLET CASING IN EYEBALL.

Fig. 61 is a good illustration of the extreme comminution due to the hardness and velocity of the modern bullet; this often has an explosive effect. Several foreign bodies are present. Complete sciatic paralysis occurred in this case after some weeks of treatment. The nerve was cut down upon and was found to be very firmly bound down in a tunnel of fibrous tissues in which callus was being deposited. The nerve was carefully freed and was wrapped up in its most adherent part in a piece of gutta-percha tissue, which was left *in situ*. The patient is still under treatment.

Fig. 62 shows part of the casing of a bullet situated about the centre of the right eyeball. Vision had been destroyed, and the eye was very painful, so excision was performed.

Fig. 63 shows fragments of a bullet situated above the pituitary fossa. These had entered in the occipital region, producing a large fracture of both tables and ploughing their way forward, probably injuring the visual centres and the fibres proceeding from these. The patient had perception of light, and it is possible some perception of large moving objects. The fundus oculi was normal, and there were no other evidences of cerebral disturbance.

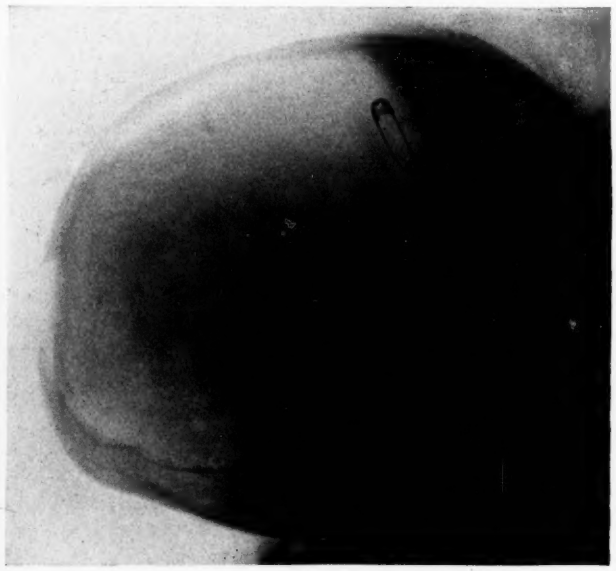

FIG. 63.—BULLET FRAGMENTS IN SKULL, ABOVE PITUITARY FOSSA.

They had entered through the occipital region and injured the patient's vision.

In spite of the gross contamination and the fouling with soil, etc., of so many of the wounds in this war, speaking broadly, conservative surgery has produced most excellent results. This is certainly true of the Indians who have been treated in this hospital. Operations that are not very urgent are much better left until the wounds have become sweet and the patient has recovered from the shock and strain of service conditions. This would seem obvious; but the results would in some cases be more favourable if the principle was always kept in mind.

INSTRUCTIVE MISTAKES.

SIMULATION OF AN OVARIAN TUMOUR BY THE ENLARGED AND DISLOCATED SPLEEN OF LEUKÆMIA.

A MARRIED woman (multiparous) was admitted with the history that she had for about two years noticed a comparatively painless swelling in the lower abdomen which had gradually increased in size. She had reached the climacteric, and there was a history of recent menorrhagia, which for two months had been succeeded by amenorrhœa. There was no very marked pallor, and no œdema or general dropsy. On abdominal examination, a smooth, hard tumour could be felt rising out of the pelvis. It reached nearly to the level of the umbilicus, and there was a distinct area of resonance between it and the costal margin. There was no respiratory movement in the tumour. It was exercising pressure on the bladder, causing frequency of and pain on micturition, and on the rectum, causing difficulty in defæcation and tenesmus. Bimanually, the tumour seemed to spring from the right ovary, and was adherent to the uterus.

Laparotomy revealed the fact that the tumour which was occupying the pelvis was an enlarged spleen with a long pedicle. No attempt was made to remove the spleen, which was adherent to the uterus and bladder, and the abdomen was closed. At about ten o'clock on the evening of operation the patient complained of a good deal of pain, looked extremely pale, and it was noticed that the dressings were saturated with blood. In a very short space of time she began to show all the signs of severe hæmorrhage. On examining further, free hæmorrhage was seen to be taking place from the incision in the abdominal parietes; there also appeared to be abdominal distention in this region. The dressings were caked with masses of friable clot of a light brownish colour quite unlike ordinary blood-clot. The patient was extremely restless and delirious. The radial pulse was nearly imperceptible; nevertheless it was considered advisable to make an attempt to deal with the source of the hæmorrhage. Intravenous infusion of saline was resorted to at an early stage in the operation. The Michel's clips were extracted and the abdominal wound examined. A considerable amount of clot was evacuated which was infiltrating the abdominal muscles and had evidently caused the swelling of the abdomen noticed before operation. The peritoneal cavity was re-opened, but was free from blood. The bleeding had evidently occurred as a general oozing of the incision in the abdominal parietes. As no definite bleeding point presented itself, and as the patient's condition was by now desperate, the abdomen was closed as rapidly as possible. Death occurred ten minutes after the patient had returned to the ward.

A post-mortem examination of the blood showed the picture characteristic of splenomedullary leukæmia, but the proportion of white to red cells was unusually high, the two varieties being approximately equal in number.

Commentary.—The spleen, when so freely movable that it may occupy almost any position in the abdomen or pelvis, or when 'dislocated', and fixed by adhesions in some new habitat, may in its abnormal situation be a very potent source of error in diagnosis. Although we may have prolapse of a more or less normal spleen in cases of visceroptosis, yet when this organ transgresses its anatomical boundaries it is in most cases enlarged. When once the phrenico-colic ligament is torn or stretched, the lienorenal ligament, gastrosplenic omentum, and splenic vessels form but a mediocre support for the spleen. It forms an interesting study to review the literature on the subject and discover what a large variety of abdominal conditions have proved, on laparotomy, to be due to the wandering or dislocated spleen. These errors in diagnosis are perhaps more apt to occur when the spleen has become dislocated—i.e., has acquired adhesions to other organs; for by dragging upon or exercising pressure on those organs it may almost exactly simulate disease in the latter.

Symptomatology.—A displaced spleen very commonly induces gastric symptoms through dragging upon the stomach; or it may press upon the colon, giving rise to symptoms of acute or chronic intestinal obstruction. It may occupy the pelvis and simulate a uterine or ovarian tumour. It has been found in the sac of an inguinal hernia. It may cause spasms of pain similar to movable kidney. The pedicle of a movable spleen may become twisted and the viscus become strangulated and give rise to acute abdominal symptoms—abdominal pain and vomiting, and later, if unrelieved, general peritonitis. It then has to be diagnosed from the other very numerous causes of the 'acute abdomen.' The symptoms may be gradual in their onset, or so sudden as to simulate a perforated viscus. Jacobson says: "I have operated on a case in which a diagnosis of intussusception had been made, the twisted and prolapsed organ having been mistaken for the tumour of that disease." One might multiply cases of this nature indefinitely; even from what has been stated, however, it is obvious how easily diagnostic errors may arise. Attention should always be given to the presence of the normal splenic dullness.

If a surgeon arrives at a certain diagnosis, and on opening the abdomen finds to his surprise an enlarged spleen which has been responsible for the trouble, he will probably remove the spleen, if possible, and the patient may be relieved or even cured of the previous symptoms. But there is one extremely important exception to this rule; if the enlargement of the spleen be due to leukæmia, death will almost certainly follow the operation, even if the spleen be not removed.

Leukæmia.—The figures given for splenectomy in these cases are very discouraging. Greig Smith gave 18 cases, Thornton 13, and Collier 16, all of which were fatal. In the more recent statistics of Johnston, only 6 out of 49 cases survived. The cause of death is hæmorrhage, due to the fact that leukæmic blood clots very slowly.

Symptomatology.—The symptoms of leukæmia with an enlarged spleen are so indefinite and equivocal that diagnosis is practically impossible in the absence of a blood examination. In women the disease is most common at the climacteric. There is progressive enlargement of the abdomen, with shortness of breath, pallor, palpitation, and other symptoms of anæmia. The pulse is rapid, soft, compressible, and often of full volume. Hæmorrhages in various situations may occur—epistaxis is common, or bleeding may take place into pleural or peritoneal cavities; there may be hæmatemesis, or cerebral hæmorrhage may bring about a fatal result.

Blood Changes.—The most characteristic change consists in the presence of myelocytes—large mononuclear neutrophilic cells which originate in the bone marrow. Polynuclear cells with coarse basophilic granules (mastzellen) are always present in considerable numbers in splenomedullary leukæmia. Small mononuclear leucocytes are hardly if at all increased absolutely, and are diminished relatively. The relative proportion of eosinophils is normal or increased; there is no great absolute increase. Polynuclear neutrophils may be in normal proportion or relatively diminished. Nucleated red corpuscles (normoblasts) may be present.

Bearing in mind the fact that the dislocated leukæmic spleen, like any other enlarged and dislocated spleen, may simulate any of the manifold conditions above mentioned; remembering further the terribly high mortality of operations in splenic leukæmia, we come to this point: that it is most advisable to examine the blood before abdominal operations more often than is done at present. We should then avoid such an occurrence as happened in the case described above.

SHORT NOTES OF RARE OR OBSCURE CASES.

OMPHALOMESENTERIC CYST, CAUSING ACUTE INTESTINAL OBSTRUCTION.

By D. P. D. WILKIE Edinburgh.

Whilst remnants of the omphalomesenteric duct, such as Meckel's diverticula and fibrous strands attached either to the umbilicus or to some portion of the mesentery, are relatively common, and frequently lead to intestinal obstruction, cyst formation in the remnants of this duct is by no means common, and as a cause of intestinal obstruction is distinctly rare. I have been able to find records of only two cases of this condition in the literature. The following instance, therefore, is worthy of record.

The case was that of a boy, age 15, who at two o'clock one afternoon was seized with acute abdominal pain and vomiting. The pain was of a griping nature, and having lasted half an hour, passed off completely. An hour later the pain returned, and he again vomited. Throughout the night these intermittent attacks of pain and vomiting continued, and on the following morning were more violent than ever. During this period the bowels had not acted, and no flatus had been passed. When seen by a doctor eighteen hours after the onset of symptoms, the boy was found to be in great pain; his temperature was normal, and the pulse-rate 84. The abdomen was somewhat tumid, and there was marked tenderness and some rigidity over the lower part of the right rectus muscle. His parents gave the history that, two years before, he had suffered from a similar though much less violent attack, which lasted for twenty-four hours, and that twelve months later he had a second attack of less severity and shorter duration. Otherwise the boy had enjoyed good health, and there was no family history of tuberculosis. Appendicitis was diagnosed and the boy was sent to hospital.

State on Admission.—Patient was a well-nourished boy. His face was drawn, and he was evidently suffering considerable pain. His temperature was 98·8° F., pulse-rate 90. The abdomen showed slight general tumidity. The boy indicated the seat of maximum pain to be just below and to the right of the umbilicus. On palpation, the abdomen felt somewhat tense, but there was very little rigidity of the abdominal muscles. There was very distinct localized tenderness over a small area situated one inch below and to the right of the umbilicus, and in this region there was an indefinite sense of resistance. In the right iliac fossa there was neither tenderness nor

rigidity. The obstipation, vomiting, griping pains and abdominal tumidity, all seemed to point to the case being one of intestinal obstruction, most probably low down in the small intestine, due either to a Meckel's diverticulum or to an adhesion, possibly to an old tuberculous gland. The symptoms

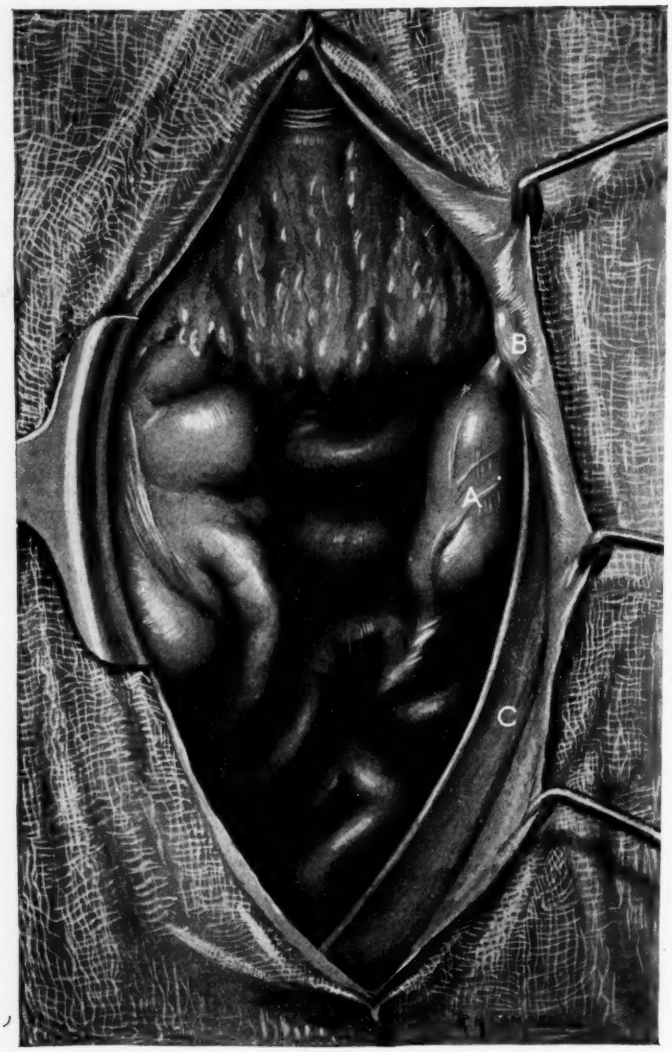

FIG. 64.—CYST IN POSITION.

(A) Large cyst with twist on pedicle, causing intestinal obstruction; (B) Small sessile cyst under peritoneum of everted abdominal wall; (C) Very prominent fold made by the obliterated hypogastric artery (*slightly exaggerated in drawing*)

were, however, compatible with an acute obstruction of the vermiform appendix.

Operation.—Under ether anæsthesia, an incision was made through the right rectus muscle below the umbilicus. On opening the peritoneum some

clear serous fluid escaped, and distended and congested coils of small intestine presented. On pulling forward the cæcum, the lower end of the ileum was seen to be more or less collapsed. It was accordingly followed upwards, and at a point about one foot from the ileocæcal junction the seat of obstruction was reached. At this point there was attached to the ileum, by a broad but twisted pedicle, a tense sausage-shaped cystic swelling, which, by its other end, was moored to the abdominal wall at the level of the umbilicus. In order to obtain a better view of the parts concerned, the abdominal wound was enlarged considerably. An omphalomesenteric cyst, pale in colour, but tense and twisted on itself, was then fully exposed. At the point of attachment to the ileum it had, by its torsion, caused an acute kink, with complete obstruction of the intestinal lumen (*Fig.* 64).

The intestinal end was first severed between forceps, when it was seen that there was a small intestinal diverticulum extending for about half an inch into the pedicle of the cyst, but that, between this diverticulum and the cyst, there was a portion of impervious pedicle. At its umbilical end it tapered into a short stout pedicle. This was clamped and cut through flush with the abdominal wall.

Two other sessile cysts could now be felt in the abdominal wall in the region of the umbilicus. By forcibly pulling up and everting the margins of the wound, one of these was brought into view. They evidently represented remnants of the omphalomesenteric duct in the abdominal wall, which had developed into separate cysts. On clipping away the peritoneal wall with scissors, they were found to contain thick mucoid fluid. When the abdominal wall was everted a very striking fold was brought into view, standing out like a hollow-ground razor. This fold, which ran from the umbilicus downwards and outwards to the lateral wall of the pelvis, contained the obliterated hypogastric artery in its free margin (*Fig.* 64). On passing a hand under the abdominal wall to the left side, a similar fold could be felt there, forming a distinct shelf.

Fig. 65.—Cyst after Removal (*half actual size*). (A) Intestinal end; (B) Umbilical end.

Having invaginated the intestinal stump of the cyst pedicle, and ascertained that the vitality of the intestine at the site of the torsion and kinking was unimpaired, the abdomen was closed.

Recovery after operation was uneventful.

On examining the cyst after the removal (*Fig.* 65), it was seen to be faintly hour-glass in shape, tense, and distended with clear mucoid fluid. The cyst wall was for the most part of fair thickness, fine aponeurotic-like fibres being stretched over it in linear fashion. In some parts the wall was thinner, and at these points it appeared that an inner lining membrane had herniated between the fibres of the covering fibro-aponeurotic layer.

No sections were cut, the specimen being preserved intact.

REMARKABLE CASE OF A TRANSFIXING WOUND OF THE CHEST CAUSED BY A RED-HOT POKER.

[COMMUNICATED.]

L. L., male, age 52. Admitted October 14, suffering from old hemiplegia and mental depression. Right hemiplegia. Low blood-pressure. No knee-jerk. No plantar extensor response. Tremors in right hand, and weak grasp.

Nov. 8.—At 12 noon, attempted suicide by transfixing completely the left side of his chest with a red-hot poker. He was found standing in front of the looking-glass, with the poker in his hand pushed down and concealed in his trouser leg. On the dressing-table cover opposite him was the stain of a spurt of blood. At first it was not evident what had happened. There was no immediate collapse of the patient. The smell of burning attracted attention, and examination led to the discovery of the poker and the wounds on the thorax.

Description of Injuries.—The anterior wound is a circular perforation, split longitudinally and charred, an inch below centre of left nipple and a quarter of an inch inside line of left nipple centre. Air escaping with respiration is easily stopped by slight pressure above nipple. Posterior wound is star-shaped, with everted edges, and charred, eight inches below spine of 7th cervical vertebra and two inches to right side of spine.

About one inch above this is a nipple-like protrusion of dead-white, hard, 'cooked,' but not charred, skin: evidently where the poker-end had failed to emerge on the first attempt.

The vest which the patient was wearing had a charred hole in front and a smaller one behind. The patient's condition was so good that it was difficult to be convinced that his thorax had been completely penetrated; but the shape of the wounds left no doubt that the anterior was a wound of entrance and the posterior a wound of exit. Later some shock was manifested—patient cold and very pale, but pulse good. Morph. hypoderm. gr. $\frac{1}{4}$ given at 6.30 p.m. Slight hæmorrhage from anterior wound, and sero-sanguineous discharge from posterior wound.

Nov. 9.—Pulse 116; Respiration 28; Temperature: morning 97·2°, evening 98°.

Fairly comfortable. Some mucopurulent expectoration *not* blood-stained. Rational. Slept at intervals. Expresses regret that he should have attempted suicide.

Some surgical emphysema over left side. In front, no breath sounds over left lung, but some vocal vibrations in axilla. Behind, resonance of tympanitic character over left scapula. Left side moves fairly. Heart sounds at apex not detected. Very large emphysematous chest 11 inches in depth between wounds.

Discharge from posterior wound has sweet odour and is grumous. Microscopically, many bacteria and large fat globules.

Nov. 10.—Morning, P. 120; R. 28; T. 99·2°. Evening, P. 116; R. 28; T. 98·8°.

Cough troublesome. Breath sounds audible over upper lobe.

Nov. 11.—Morning, P. 112; R. 28; T. 100·2°. Evening, P. 112; R. 28; T. 98°.

Air no longer whistles to and fro from anterior wound, probably because inflammatory changes block the narrow sinus. Discharge from posterior wound becoming very offensive.

Nov. 12.—Morning, P. 116; R. 28; T. 99·8°. Evening, P. 116; R. 28; T. 97·4°.

Fragments of 'cooked' muscle fibre protruding from posterior wound, which is showing signs of sloughing. Discharge very offensive.

Nov. 13.—Morning, P. 112; R. 32; T. 99°. Evening, P. 104; R. 32; T. 97·8°.

Several sloughs are separating about both wounds, and air is now entering anterior wound as before.

Nov. 14.—Morning, P. 104; R. 32; T. 98°. Evening, P. 116; R. 32; T. 98°.

Sputum is blood-stained. Copious discharge is expelled from posterior wound on coughing, and is very offensive. Both wounds now enlarged by separation of the sloughs. Air freely flows to and fro in both; over the left upper lobe there are breath sounds, but not behind.

Subsequent progress was characterized by rising temperature; profuse discharges; pus presenting under skin of back; failing pulse; hæmorrhages from posterior wound on Nov. 26.

Nov. 26.—Died at 4.40 p.m. No post-mortem could be arranged.

Report on Discharge from Posterior Wound.—The fluid from chest is turbid, brownish in colour, has a peculiar faint odour, contains blood and fat in fine division.

Films show:—

Droplets of fat of various size.
Red blood-cells.
Polymorphonuclear leucocytes in all stages of decay. Many are crowded with Gram-positive cocci. In others a few spaces—(?) fat.
Large mononucleated cells.
Bacteria in great abundance: (*a*) Large Gram-positive anaerobic bacilli; (*b*) Staphylococci; (*c*) Short-chained streptococci; (*d*) Gram-negative bacilli (coliform).
Shreds of material from dressings.
Fibres of striped muscle.

Remarks.—Patient is a very large man with an unusually deep chest. It is most astonishing that he was able to completely penetrate his chest; probably some collapse of lung occurred, allowing the poker a free passage to posterior wall. It is difficult to believe the poker, which was old, bent, and much worn, could have retained sufficient heat to char the wound of exit after penetrating eleven inches of moist tissues. The extraordinary absence of immediate shock; the low evening and higher morning temperatures; the mixed infection; the general well-being of the patient up to the last few days; the extensive sloughing of the skin and tissues about the posterior wound; and the rapid clearing of the anterior wound: all these are points of great interest.

SACRO-COCCYGEAL TERATOMA.

By GWYNNE WILLIAMS, London.

H. P., a female child, age 7 months, was admitted into University College Hospital on October 31, 1914, with a large tumour in the sacral region which had been present since birth. It had not given rise to any difficulty at the delivery, and had grown with the child.

The patient was healthy and well-developed, and sat up in bed, using the tumour as a cushion on which to sit. The tumour was a large lobulated swelling between the anus and the sacrum, and was about four inches in diameter from the tip of the coccyx to the anus. It extended on each side into the buttock about half-way to the iliac crests. The consistence

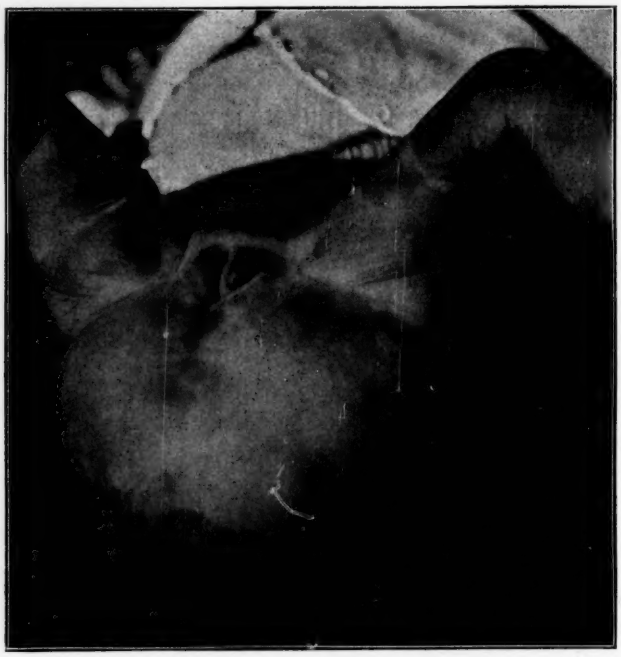

Fig. 66.—The patient before operation.

varied; on the right side there was a fluctuating lobule which was translucent, while elsewhere it gave the impression of a soft solid tumour. The coccyx was pushed backwards, while the anus seemed to be situated on the front of the mass. There were two nævoid patches on the skin, which was otherwise normal.

The sacral promontory could be felt through the rectum, but the lower part of the bone was obscured by the tumour. *X* rays showed no change in the skeleton. There were no paralyses of the lower limbs, and both sphincters were intact.

Operation (November 26, 1914) under chloroform and ether.

The patient was in the semi-prone position, and an assistant had a finger

in the rectum. A transverse incision was made over the posterior aspect of the tumour, with a vertical median extension upwards over the coccyx and sacrum. Laterally the mass was found to be deep to the gluteus maximus, and some fibres of this muscle were removed. The flap of skin and subcutaneous fat was turned downwards, and the tumour enucleated fairly easily, without much loss of blood. On the right side a large cyst containing a clear colourless fluid was burst. The sacro-coccygeal joint was cut across, and the coccyx removed with the tumour, which at this point was somewhat adherent to the sacrum, so that it was cut into in tying the middle sacral artery and a

FIG. 67.—The patient after operation.

small cyst containing sebaceous-looking material opened. The tumour was very close to the rectum, but the presence of the assistant's finger made the separation quite easy, and it could not be said to invade the wall of the gut. Redundant skin was removed and the wound closed. It was dressed with boracic fomentations, which were changed every hour, and the wound healed satisfactorily. No paralysis of the sphincters followed the operation.

On section, the central part of the mass was found to consist of fat. Histologically, the margin showed islets of cartilage, masses of very vascular areolar tissue, and islets of gland tissue resembling a serous salivary gland. The walls of the large cyst contained goblet cells, and outside this were acini of the gland-tissue mentioned above.

GUNSHOT WOUND OF ARM AND CHEST.

[COMMUNICATED.]

T. W., age 23, was wounded by shrapnel at Neuve Chapelle, March 11, 1915. He was admitted to the General Hospital on March 22, with granulating wounds on the outer and back surfaces of the right arm, and another in

the axilla, all apparently caused by the same projectile. There was no pyrexia, and there were no physical signs excepting those of fluid at the left base and slight displacement of the heart to the right. *X* rays showed nothing abnormal in the chest except fluid at the left base.

On March 30 an exploring syringe in the 7th space discovered slightly turbid fluid. The following day aspiration in the 8th space obtained only about one ounce of blood. Patient began to complain of some pain in the left hypochondrium, aggravated by food. There was now marked rigidity below the left costal margin in front.

By April 8, a fairly tense cystic swelling, round and even, clearly defined at its lower margin, could be felt projecting below the left costal margin and extending into the flank. There was no sign of any connection with the liver; an area of resonance over the summit was apparently gastric; there were no renal symptoms; the appetite was failing, owing to the discomfort felt after meals. The temperature, which had oscillated a little after admission—rising once to 100°—was now steady.

These symptoms, becoming aggravated, continued till April 13, when a second *x*-ray examination of the abdomen revealed a shrapnel bullet in the left side, between the last rib and the iliac crest.

April 14.—Under open ether, the abdomen was incised external to the left rectus. A retroperitoneal cyst, overlaid by stomach and omentum, presented. The incision was closed. A posterior incision was then made as for a left kidney operation. The kidney was exposed and held back. The cyst in front of the kidney was opened, and several pints of clear, odourless, slightly blood-stained fluid were evacuated. The bullet was found embedded in some loose fat, and removed. A large drainage-tube was inserted.

The fluid did not yield active pancreatic reactions when tested with starch, milk, and white of egg.

April 16.—The fluid was still discharging copiously, and was blood-stained. The dullness, so marked at the left base before the operation, had disappeared.

April 18.—The discharge began to contain much thick mucus.

April 23.—The temperature, which was 102° on the 15th, has fallen gradually and is now normal. The anterior abdominal incision has quite healed.

May 3.—The temperature has been oscillating for a week between 98° and 100°. The posterior wound is granulating, and discharging a brown, viscid mucus. There are signs of fluid at the left base again.

May 6.—Exploration in the 8th space yielded blood-stained fluid similar to that evacuated at the operation. Exploration in the 7th space gave clear, straw-coloured fluid.

May 13.—The signs of fluid at the base were less marked and the temperature was again steady. On the 18th, the patient was discharged to a subsidiary hospital.

The chief interest of the case is the escape from injury of the vital organs lying between the wound of entrance, high up in the right axilla, and the point in the left lumbar region in which the bullet was found encysted in the retroperitoneal fat.

GUNSHOT WOUND OF HEAD: SUBDURAL HÆMORRHAGE.

[COMMUNICATED.]

H. B. came under shrapnel fire on Jan. 31, and was sprayed with small fragments of projectile in the right malar and temporal regions. He was admitted to a base hospital at Boulogne, and transferred to the General Hospital on Feb. 12. There were then many small, superficial, and scabbed wounds in the right malar and temporal regions. *X*-ray examination was negative. The man had never been unconscious, and did not complain of anything. His pulse and temperature were normal. After being under observation for a week he was thought fit to be discharged.

Feb. 20.—Patient complained of some right temporal headache, which soon became severe. The pain was constant, with exacerbations; the man lay huddled in bed, reiterating "Oh dear! Oh dear!" There were intervals when he was silent and bright, but his song was resumed the moment a medical officer was discovered to be in the ward. There were periods of obvious pain, when he presented the appearance of an acute trigeminal neuralgia. The ears, teeth, and sinuses were all normal. On Feb. 25, the right retinal veins were somewhat dilated, on the 26th the pulse was 60, and on the 27th, 56; by that date there was + 3 of swelling of the right disc, and the left disc was choked; there was no oculo-motor paralysis.

March 2.—All the sinuses were again examined and found apparently healthy. The optic neuritis had increased on both sides. The pulse had fallen to 50, and the temperature was constantly subnormal.

March 3.—Operation. Intratracheal anæsthesia. Horseshoe-shaped incision from 1 inch behind the right eye to mastoid. Several minute pieces of metal found in the soft parts. A circle of skull two inches in diameter was removed by trephining. The dura, which was pulseless, was incised by cross cuts. The deep surface of the dura was found lined with old blood-clot a quarter of an inch thick. This clot was removed as far as possible, and with it a good deal of old fluid blood. Several bleeding vessels on the pia mater were ligatured with great difficulty. The dura was closed by a single catgut stitch, and the musculo-cutaneous flap by silkworm-gut sutures. The operation lasted 75 minutes; the general condition was good throughout, the pulse becoming irregular once.

March 5.—After the first twenty-four hours, when morphia had to be given, the patient had little pain.

March 21.—The wound has healed satisfactorily. The swelling of both discs is subsiding, the right becoming paler and more streaky than the left; right + 3 D, left + 2·5 D.

April 9.—The right disc is clear, rather pale, the left still paler; both about 1·5 D.

April 20.—Both discs are clear, with good vascularity. Vision: right, J 5, distant about ½; left, J 2, distant normal. Patient is irritable and easily upset; memory fair. Mentally he is slow and dull; but the head and face are of a low type.

The striking feature of this case is the delay in the appearance of any symptom in spite of the comparative gravity of the lesion.

REVIEWS AND NOTICES OF BOOKS.

A Text-book of Radiology. By E. Reginald Morton, M.D., F.R.C.S., Past President Section of Electro-therapeutics, Royal Society of Medicine. Demy 8vo. Pp. 221 + xvi, with 26 plates and 72 illustrations. London: Henry Kimpton. 7s. 6d. net.

The theory and practice of *x* rays are so much to the fore just now, in connection with the great amount of work being done on our returned wounded soldiers and sailors, that Dr. Morton's book on radiology appears at a very opportune moment. Many men who have little experience in radiological technique are helping in *x*-ray examinations in the present crisis, and in the *Text-book of Radiology* such men will find very valuable information and help. It is essentially elementary, and does not enter into abstruse problems which frequently present themselves to the more advanced worker; but for the beginner it is excellent.

There is a good chapter on the handling of *x*-ray tubes. Most workers know that in the wise treatment of their tubes lies to a very large extent the success or failure of their examinations. No matter how excellent may be the outfit, one cannot get good results apart from a thorough knowledge of the habits and mood of the tube. The novice will find some really useful information here.

The chapters on the general Roentgen outfit are good. We would have liked, at a time like the present, to have seen a good deal more space devoted to a description of the methods used in the localization of foreign bodies. This is a most important branch of Roentgenology, and one which we think would have repaid more thorough treatment.

The illustrations are good and the book is interestingly written. We hope that one day Dr. Morton may be tempted to undertake a larger work on more advanced lines. Here the author set out to explain the elementary principles and practices underlying *x*-ray work, and in this we think he has been most successful.

Précis de Chirurgie de Guerre. By Edmond Delorme, Médecin-Inspecteur-Général de l'Armée. Small 8vo. 232 pp., illustrated. Paris: Masson & Cie. 4 fr. 50.

This handbook of military surgery has a special claim upon the attention of all medical men in these times, both on account of the distinguished position of the author—Médecin-Inspecteur-Général de l'Armée—and of the richness of his experience, beginning, as he tells us in the preface, in the war of 1870, and continued to the month of September, 1914. The study of such a book brings forcibly to mind the thought that the day of the general surgeon, omniscient of the surgery of every system of the body, has passed away. The enormous complexity of modern surgery, combined with the bias of the individual practitioner in one direction or another, has resulted in times of peace in the evolution of the surgeon distinguished as an authority on the surgery of the brain and spinal cord, the abdomen, the genito-urinary tract, the rectum, and many another system grouping, whilst of necessity he is often far from being an authority upon branches of surgery other than that one which he has made peculiarly his own. In times of war he must once more resume the burden of the surgical diseases of all systems; and to those who, aware of their deficiencies from a previous absorption in the surgery of a particular system, conscientiously strive to compensate for them by reference to other authorities, this book will be of some value. But the volume, like the individual, suffers a little from the defects of an inevitable system of specialization in modern surgery. We cannot think that the

abdominal surgeon will find much solace from the perusal of the chapters on wounds of the skull, brain, and spinal cord. No mention is made of cerebral œdema and hæmorrhage, submuscular decompression operations are not alluded to, whilst the statement that "hæmatic compression of the spinal cord diminishes rapidly and spontaneously; this shows the uselessness of intervention" can hardly pass unchallenged. It is not in the least degree material to the well-being of the patient whether his skull is 'cracked,' 'fissured,' 'fractured,' or 'grooved': what is important is the degree of injury of the underlying viscus, the brain, and no problem of diagnosis presents greater difficulties; neither diagnosis nor treatment have much attention paid to them in this chapter.

The views of the author upon the treatment of compound fracture of the femur will be immediately sought for by those who have had any experience of the treatment of the wounded in this war. He writes with enthusiasm of his own valvular gutter splint, and his 'complementary treatment' by forced constipation should have alike the gratitude of the patients and the nurses for its obvious abolition of much unnecessary suffering.

In wounds of the abdomen, he urges a commendable conservatism, and is a warm advocate of 'Murphy's buttonhole' incision for pelvic drainage. Conservatism is the key-note of the whole book, and herein lies its chief value as a guide to those who through the exigencies of warfare have to assume responsibilities in surgical problems for which their civil life—often that of the general practitioner—has but inadequately equipped them. We can only hope that at the conclusion of the war so distinguished a writer may be inclined to write still one more book on military surgery, amplified and enriched by his experiences in the present campaign.

The same volume also comes to us in English dress, excellently translated, under the title "War Surgery," by Dr. H. de Méric, Surgeon to the French Hospital in London, and should prove of great value to those who read more easily in the English language. H. K. Lewis, London, is the publisher. 5/- net.

Local Anæsthesia: Its Scientific Basis and Practical Use. By Prof. R. Heinrich Braun. Translated and edited by Percy Shields, M.D., Cincinnati, from the third German edition. Quarto. Pp. 399, with 215 illustrations. London: Henry Kimpton. 21s. net.

The fact that a book of this size can now be devoted entirely to the subject of local anæsthesia is a proof of the rapid strides which have been made of late years in this direction. In fact, the work goes to show that almost all operations on the human body can now not only be performed under local anæsthesia, but can be performed with greater exactitude and safety than under general anæsthesia.

The first portion of the book is devoted to the history of the method, the different ways of securing local anæsthesia, and the theories of action of the various drugs used. The second portion deals with the chemistry of the different agents used in the production of anæsthesia, and the various methods of using each. The third portion consists of minute details of some of the operations which can be performed under local anæsthesia. The author shows a marked preference for novocain used in combination with suprarenin in weak solutions not exceeding 0·5 per cent novocain. The amount of this drug in weak solution which may be used with safety seems to have practically no limit.

The operations are clearly and concisely described, and the instructions given for the points of injection and the depths to which the needle may be safely passed are accurate and minute.

The book is profusely illustrated with excellent drawings and diagrams, and with photographs of actual operations; but it is difficult to believe that such extensive operations on the head and neck as those depicted are possible under local anæsthesia except in the hands of the most expert.

The book is well written, the paper and general arrangement are good, and the printing is excellent. It is a most valuable work on local anæsthesia, and one which can be highly recommended to all who may be interested in this very useful subject.

The Clinics of John B. Murphy, M.D. Vol. III., No. 6, December, 1914, and Vol. IV., No. 1, February, 1915. Philadelphia: W. B. Saunders Co. 35s. net per annum.

MURPHY'S Clinics may now be regarded as a well-established periodical, and no extended notice of these two numbers is needed. They continue to bear witness to Dr. Murphy's energy and originality. Some readers may resent the lack of form and finish inseparable from the day-to-day reporting of clinical teaching; but the fact remains that the reader who cares more for matter than for style will find his account in these volumes.

"SOME NOTES ON FISTULA IN ANO."

DR. N. PRESCOTT, Foochow, writes:—

In the BRITISH JOURNAL OF SURGERY, January, 1915, Mr. Mitchiner, writing on fistula in ano, suggests that the difference between male and female clothing accounts for the large excess of the male over the female cases.

As far as our experience goes, we have roughly the same proportion in this part of North China. But male and female clothing are practically identical in every way—both sexes wear trousers, alike in make and texture. This fact would appear to show that male clothing in England has nothing to do with the increased proportion of males affected.